TOSHIBA

DOCUMENT: NBZ0003

INSTRUCTION MANUAL

INSTALLATION - OPERATION - MAINTENANCE

TE SERIES

Low Voltage
Digital Solid State Starter

18 - 1250 A

Issued: 10/09
Manufactured in the USA

SAFETY

IMPORTANT MESSAGES

Read this manual and follow its intructions. Signal words such as DANGER, WARNING and CAUTION will be followed by important safety information that must be carefully reviewed.

DANGER	Indicates a situation which will result in death, serious injury, and severe property damage if you do not follow instructions.
 WARNING	Means that you might be seriously injured or killed if you do not follow instructions. Severe property damage might also occur.
 CAUTION	Means that you might be injured if you do not follow instructions. Equipment damage might also occur.
 **NOTE**	Give you helpful information.

NOTE: The contents of this manual will not become a part of or modify the warranty policy, the terms of which are set forth at the end of this manual.

READ SAFETY SIGNS

To avoid injury, you must read and follow all safety signs.

Keep the safety signs visible and in good shape. Never remove or cover any safety sign.

DANGER

QUALIFIED OPERATORS ONLY

Only qualified persons are to install, operate, or service this equipment according to all applicable codes and established safety practices.

A qualified person must:

1) **Carefully read the entire instruction manual.**
2) Be skilled in the installation, construction or operation of the equipment and aware of the hazards involved.
3) Be trained and authorized to safely energize, de-energize, clear, ground, lockout and tag circuits in accordance with established safety practices.
4) Be trained and authorized to perform the service, maintenance or repair of this equipment.
5) Be trained in the proper care and use of protective equipment such as rubber gloves, hard hat, safety glasses, face shield, flash clothing, etc. in accordance with established practices.
6) Be trained in rendering first aid.

SAFETY

SAFETY CODES

Toshiba motor control is designed and built in accordance with the latest applicable provisions of NEMA and the National Electrical Code. Installations must comply with all applicable state and local codes, adhere to all applicable National Electric Code (NFPA 70) standards and instructions provided in this manual.

DANGER **HAZARDOUS VOLTAGE will cause severe injury, death, fire, explosion and property damage.**

- Turn off and lock out Primary and Control Circuit Power before servicing.
- Keep all panels and covers securely in place.
- Never Defeat, Modify, or Bypass any Safety Interlocks.
- Qualified Operators only.

WARNING

Never attempt to install, operate, maintain or dispose of this equipment until you have first read and understood all of the relevant product warnings and user directions that are contained in this Instruction Manual.

Use only Toshiba-authorized replacement parts.

This equipment is designed and built in accordance with applicable safety standards in effect on the date of manufacture. Unauthorized modifications can result in voiding the warranty, severe injury, death and property damage. Do not make any modifications to this equipment without the written approval of Toshiba.

For assistance, address correspondence to:

Toshiba International Corporation
Field Service Department
13131 West Little York Road
Houston, Texas 77041 USA

or call: (713) 466-0277 Fax: (713) 466-8773
(800) 231-1412
(800) 527-1204 (Canada)

Please complete the following information for your records and retain with this manual:

Model: _____

Serial Number: _____

Date of Installation: _____

Inspected by: _____

Reference Number: _____

Table of Contents

TE Series Digital Solid State Soft Starter 18 – 1250A

Chapter 1 - Introduction

1.1 General Description

The ***TE Series*** is a digitally programmable solid-state reduced voltage soft starter. Its six SCR design features a voltage/current ramp with an anti-oscillation circuit for smooth load acceleration. The SCRs are sized to withstand starting currents of 350% for 30 seconds and up to 600% for 10 seconds. The ***TE Series*** features smooth, stepless ramp control, which reduces motor inrush current and excessive wear on the mechanical drive train components. The ***TE Series*** includes a programmable keypad for setting operating parameters for the ideal starting cycle and protection features, plus easy to understand diagnostic LEDs. Starting torque, ramp time, current limit, dual ramp, and Decel control are standard features on the ***TE Series***, as well as the integrated Batch Process Timer and Time Clock Controller used for automated applications. By simply adjusting the unit's starting torque, ramp time and current limit functions, the starting electrical characteristics of the motor can be matched to the mechanical characteristics of the drive train for controlled acceleration of the load. The ***TE Series*** includes solid-state electronic overload protection in addition to numerous other protective features. It requires 120VAC (240VAC optional) control power and uses dry contact inputs for Start / Stop control. Programmable auxiliary contacts and provisions for interlocking are also included.

1.1.1 Control Features

Acceleration Adjustments	Programmable Ramp Types: Voltage Ramp (VR) or closed loop Current Ramp (CR) Starting Torque: 0 - 100% of line voltage (VR) or 0 - 600% of motor FLA (CR) Ramp Time: 1 to 120 seconds Current Limit: 200 - 600% (VR or CR)
Dual Ramp Settings	4 Options: Ramps 1 & 2 = VR, Ramp 1 = VR, Ramp 2 = CR, Ramps 1 & 2 = CR; Ramp 1 = CR, Ramp 2 = VR Dual Ramp Control: Ramp #1 = Default, Ramp = #2 selectable via dry contact input
Deceleration Adjustments	Begin Decel Level: 0 - 100% of line voltage Stop Level: 0 to 1% less than Begin Decel Level Decel Time: 1 - 60 seconds Programmable to Decel or coast to stop upon overload trip
Jog Settings	Jog function selected via dry contact closure input. Voltage Jog: 5 - 100% Time of Voltage Jog: 1 - 20 seconds Current Jog: 100 - 500%
Kick Start Settings	Kick Voltage: 10 - 100% Kick Time: 0.1 - 2 seconds
Process Timer (2 modes)	Minimum Batch Timer: Runs until timer expires Maximum Batch Timer: Runs unless timer expires Range: 0 - 9999 minutes
Real Time Clock (RTC) Controller	24/7 Time Clock Controller Range: 1-24 hours, and 1- 7 days per week, 1 - 7 start events per day, works with Process Timer for run time

1.1.2 Advanced Motor Protection Features

Thermal Model Electronic Overload Protection	A sophisticated Thermal Model of the motor operation is created in the microprocessor to accurately track all starting, stopping and running conditions to provide maximum motor protection.
Two Stage Overload Curves	Starting: Programmable for Class 5 or 10 Run: Programmable for Class 5 through 30 when "At-Speed" is detected.
Overload Reset	Manual (default) or automatic
Retentive Thermal Memory	Overload circuit retains thermal condition of the motor regardless of control power status. Unit uses real time clock to adjust for off time.
Dynamic Reset Capacity	Overload will not reset until thermal capacity available in the motor is enough for a successful restart. Starter learns and retains this information by monitoring previous successful starts.
Current Imbalance Trip	Trip Level: 5 - 30% Imbalance in any two phases Trip Delay: 1 -20 seconds
PTC Input Trip	Trips on greater than 750 ohms resistance on a dedicated PTC input. Can be used with an Emergency Stop or any other External Lockout.
Over Current Trip (Electronic Shear Pin)	Trip Level: 50 - 300% of motor FLA Trip Delay: 1 - 20 seconds
Phase Loss	Trips on any phase current less than 20% of unit rating. Can be disabled in programming for testing with smaller loads.
Equipment Ground Fault Protection	Type: Residual Current Trip Range: 5 – 90% of unit CT ratio Trip Delay: 1 – 60 seconds
Load Loss Trip	Under Current Trip Level: 10 –90 % of motor FLA Trip Delay: 1 – 60 seconds
Coast Down (Back Spin) Lockout Timer	Prevents restart when motor may be spinning backwards Coast Down Time Range: 1 – 60 minutes
Starts-per-hour Lockout	1 – 10 successful starts per hour
Minimum Time between Starts Lockout	Range: 1 – 60 minutes between start attempts
Restart Delay	Sequential Start Feature for restarting delay after a power outage. 1-999 seconds after a power loss
Auto Reset	Can be programmed to attempt resetting after selected faults 0 – 10 Attempts, 0 – 999 minutes delay between attempts
Power Device Monitoring	Shorted SCR Lockout (1 shorted SCR) and independent Shunt Trip (multiple shorted SCRs). Can be disabled in programming.

1.1.3 Design Specifications

Type of Load:	Three phase AC induction motors
AC Supply Voltage:	Universal, 208 - 600VAC ±10%, 50/60 Hz
Power Ratings:	18 - 1250 Amps, 7.5 - 1000 HP @ 460V
Unit Capacity - Continuous	Max. Amp rating is UL Listed continuous rating
Unit Capacity - Overload Rating (Percent of motor FLA)	350% - 30 seconds
	600% - 10 seconds
Power Circuit	6 SCRs, full phase angle firing using a hard fire picket firing circuit and "Back Porch" DC carryover to avoid motor transient problems
SCR Firing Angle Detection	6 pulse Independent Locked Phase Tracking with Auto-synchronization, prevents misfiring on unstable source frequency
SCR PIV Ratings (Peak Inverse Voltage)	1600V
Phase Rotation	Operates with any phase sequence, or programmable rotation trip ABC / ACB / Off
Transient Protection	RC snubber dv/dt networks on each phase
Cooling	Fan assisted convection
Bypass Contactor	Standard on all NEMA 12 enclosed units
Units 160A and less:	Standard on all open panel units (-BP versions)
Units 210A and over:	Optional on open panel units (-BP versions)
Bypass Contactor Rating	Shunt rated or can be sized for Line start rated contactor (see charts)
Bypass Contactor Control	Integral control is included, but contactor can be externally controlled as well.
Ambient Condition Design	Open panel mount units: 0° to 50 °C (32° to 122°F)
	Factory enclosed units: 0° to 40°C (32° to 104°F)
	5 - 95% relative humidity
	0 - 3300 ft. (1000m) above sea level without derating
Control Power	120VAC (customer supplied), 240VAC optional
Inputs	6 Dry (voltage free) contact inputs using 24VDC from an internal power supply
Programmable Outputs	3 relays, 2 each Form C (SPDT), 1 each Form A (SPST). Can be programmed for 26 functions, with delays or flashing.
Output Relay Contact Rating	5 Amps, 240VAC max. (1200VA)
Dedicated Fault Output	AC Triac solid state switch
	240VAC/DC, 50mA max.
Approvals	UL Listed, Canadian UL (cUL) Listed, CE Approved

1.2 Sizes and Ratings

The Toshiba ***TE Series*** starters are current rated controllers. Max. Amp ratings are for continuous duty and must not be exceeded. Always check the motor nameplate FLA and Service Factor to ensure proper sizing.

Each size has an adjustable range of current from 50% to 100% of the Max Amp rating. Table 1.2 below shows the Current Ratings available.

Model Number	Current Range Min. - Max.
TE-18-BP	9 - 18
TE-28-BP	14 - 28
TE-39-BP	19 - 39
TE-48-BP	24 - 48
TE-62-BP	36 - 62
TE-78-BP	39 - 78
TE-92-BP	46 - 92
TE-112-BP	56 - 112
TE-150-BP	75 - 150
TE-160-BP	80 - 160
TE-210-BP or -P	105 - 210
TE-275-BP or -P	138 - 275
TE-360-BP or -P	180 - 360
TE-450-BP or -P	225 - 450
TE-550-BP or -P	275 - 550
TE-718-BP or -P	359 - 718
TE-900-BP or -P	450 - 900
TE-1006-BP or -P	503 - 1006
TE-1250-BP or -P	625 - 1250

Table 1.2: TE Series Range

1.2.1 Selecting for Service Factor Utilization

Many NEMA design motors include a design rating referred to as Service Factor (SF) that may allow continuous operation above the nameplate current rating. If using this Service Factor, the ***TE Series*** starter must be sized for the total amps used. For proper selection of the ***TE Series*** starter when using SF continuously, multiply the nameplate FLA by the stated Service Factor, or use stated Service Factor Amps (SFA) if listed on the nameplate. Following is an excerpt from the NEMA MG-1 standards for AC Motors that describes the issues concerning the use of Service Factor ratings.

"*When an induction motor is operated at any service factor greater than 1.0, it may have efficiency, power factor and speed different than those at rated load. Locked rotor torque and current and breakdown torque will remain the same. A motor operating continuously at any service factor greater than 1.0 will have a reduced life expectancy compared to operating at its nameplate horsepower.*"

When using this feature, simply program the ***TE Series*** Service Factor (F002) to the nameplate rating see section 5.6.1. All other adjustments to protection circuits are done automatically within the ***TE Series.***

1.2.2 Selecting for Across the Line Bypass

If you need to be able to start the motor Across-the-Line if the ***TE Series*** electronics are out of service, the starter can also be selected based upon the rating of the Bypass Contactor. Some users may also elect to size their Bypass Contactors per NEMA guidelines. Please use the Product Price Catalog for details and notes on doing this, and see Appendix 5 for special considerations regarding Overload Protection.

- **NOTE:**
  The ***TE…-BP Series*** starters include the ability to connect a dry contact directly to the Bypass Contactor coil control circuit. These terminals shipped are covered and should be used ONLY when necessary for Emergency Bypass operation ***and*** with an external Overload Relay. See Appendix 5 for additional information.

  No field wiring is necessary to these terminals if this feature is not used.

Chapter 2 - Installation

2.1 Receiving and Unpacking

Upon receipt of the product, you should immediately do the following:

- Carefully unpack the unit from the shipping carton and inspect it for shipping damage (if damaged, notify the freight carrier and file a claim within 15 days of receipt).
- Verify that the model number on the unit matches your purchase order.
- Confirm that the ratings sticker on the unit matches or is greater than the motor's HP and current rating.

2.2 Choosing a Location

Proper location of the ***TE Series*** is necessary to achieve specified performance and normal operation lifetime. The ***TE Series*** should always be installed in an area where the following conditions exist:

- Ambient operating temperature:
  Panel (open chassis) unit: 0 to 50°C (32 to 122°F)
  Enclosed unit: 0 to 40°C (32 to 104°F)
- Protected from rain, moisture and direct sun.
- Humidity: 5 to 95% non-condensing
- Free from metallic particles, conductive dust and corrosive gas
- Free from excessive vibration (below 0.5G)
- Open panel units must be mounted in the appropriate type of enclosure. Enclosure size and type must be suitable to dissipate heat generated by the soft starter and any other components mounted inside with it.
- **Units with –BP Bypass Contactors** produce less heat than units without. Throughout all sizes, maximum heat dissipation of the TE…-BP Series electronics, contactor coils and fans is less than 50W.
- **Units without the –BP Bypass Contactor** (optional on 210A and above), must have ventilation adequate to account for heat dissipation of the SCRs. This must be estimated at 4.5 watts per running load amp. For example, on a 200HP 460V motor with 240FLA, the maximum heat dissipation of a starter w/o bypass will be 240 x 4.5, or 1080 watts of heat. Enclosure ventilation (or air conditioning) must be capable of dispersing this amount of heat.
- Care should always be taken to maximize the available space inside of the enclosure. See section 2.5.1 or contact factory for assistance in sizing enclosures.

2.3 Initial Unit Inspection

Make a complete visual check of the unit for damage that may have occurred during shipping and handling. Do not attempt to continue installation or start up the unit if it is damaged.

- Check for loose mechanical assemblies or broken wires which may have occurred during transportation or handling. Loose electrical connections will increase resistance and cause the unit to function improperly.
- Prior to beginning the installation, verify that the motor and ***TE Series*** unit are rated for the proper amperage and voltage.

2.4 SERVICE WARNING!

Do not service equipment with voltage applied! The unit can be the source of fatal electrical shocks! To avoid shock hazard, disconnect main power and control power before working on the unit. Warning labels must be attached to terminals, enclosure and control panel to meet local codes. Use Lock Out tags such as the one shown when servicing equipment.

2.5 Mounting and Cleaning

When drilling or punching holes in the enclosure, cover the electrical assembly to prevent metal filings from becoming lodged in areas which can cause clearance reduction or actually short out electronics. After work is complete, thoroughly clean, vacuum the area, and re-inspect the unit for foreign material.

2.5.1 Clearances

Make sure there is sufficient clearance all around the unit for cooling, wiring and maintenance purposes. To conserve panel space, the ***TE Series*** –BP models were designed for close horizontal clearances of only 1 inch (25mm) on either side. A minimum vertical clearance of 4" (100 mm) on the top and bottom is necessary to maximize effective airflow and cooling, and the unit must be installed with its heat sink ribs oriented vertically and running parallel to the mounting surface. Keep in mind that these are minimums. Wiring may require more clearance, particularly on the bottom.

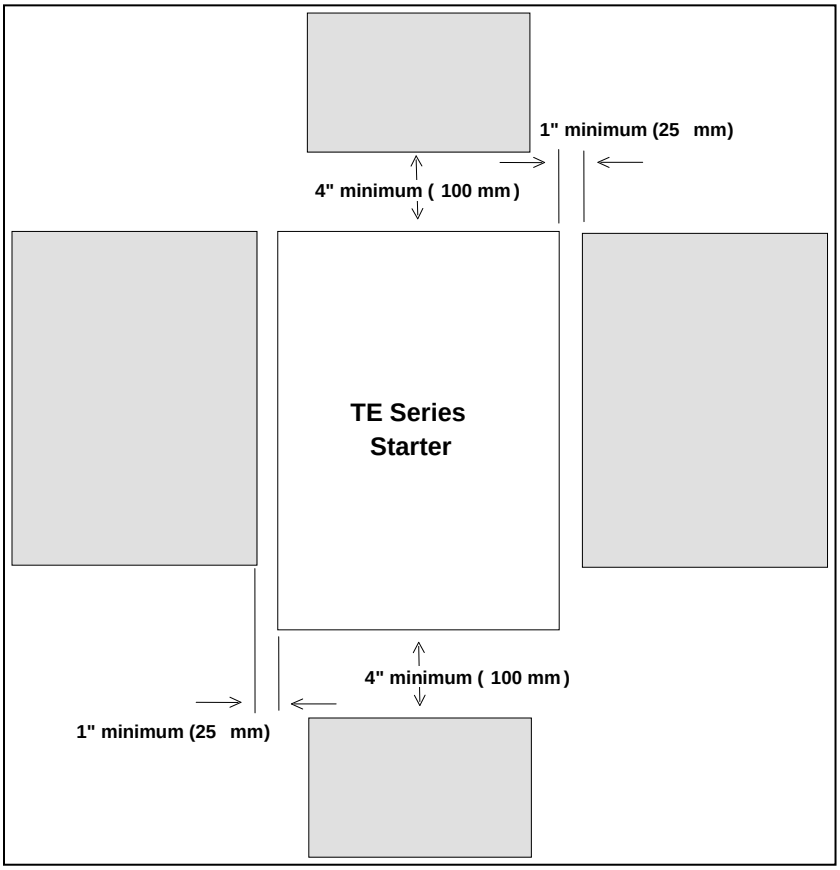


Figure 2.5: TE minimum mounting clearances

WARNING

Remove all sources of power before cleaning the unit.

In dirty or contaminated atmospheres, the unit should be cleaned on a regular basis to ensure proper cooling. Do not use any chemicals to clean the unit. To remove surface dust use clean, dry compressed air only, 80 to 100 psi. A three-inch, high quality, dry paintbrush is helpful to loosen up the dust prior to using compressed air on the unit. Do not use wire brushes or other conductive cleaning materials.

2.6 Power Terminations

All line and load power terminations are to be made to tin plated copper Bus Tabs located on each unit. Bus tabs are pre-drilled to accept industry standard bolts. Some sizes come with saddle clamp terminals, however lugs are the responsibility of the user. Toshiba recommends using crimp-on lugs, although mechanical lugs are suitable as well. The following diagrams show sizes of the bus tab holes and critical spacing between them for determining the size of lug that can be used.

NOTE: All wiring must be sized according to local code standards.

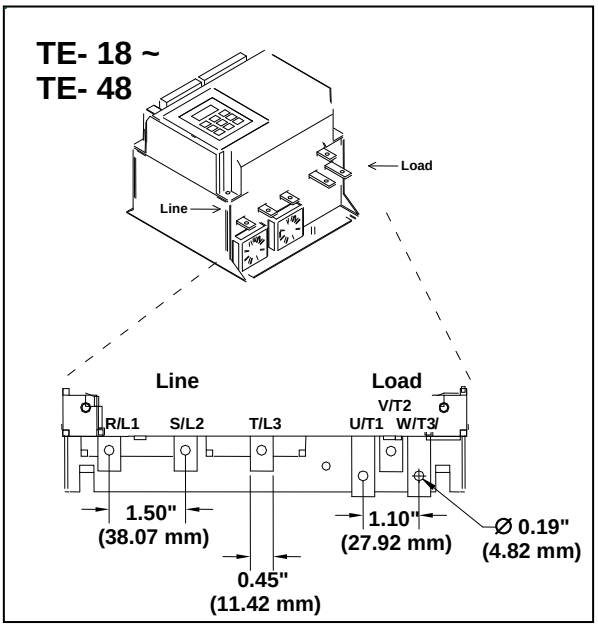


Figure 2.6.1 Critical clearances for bus tab connections

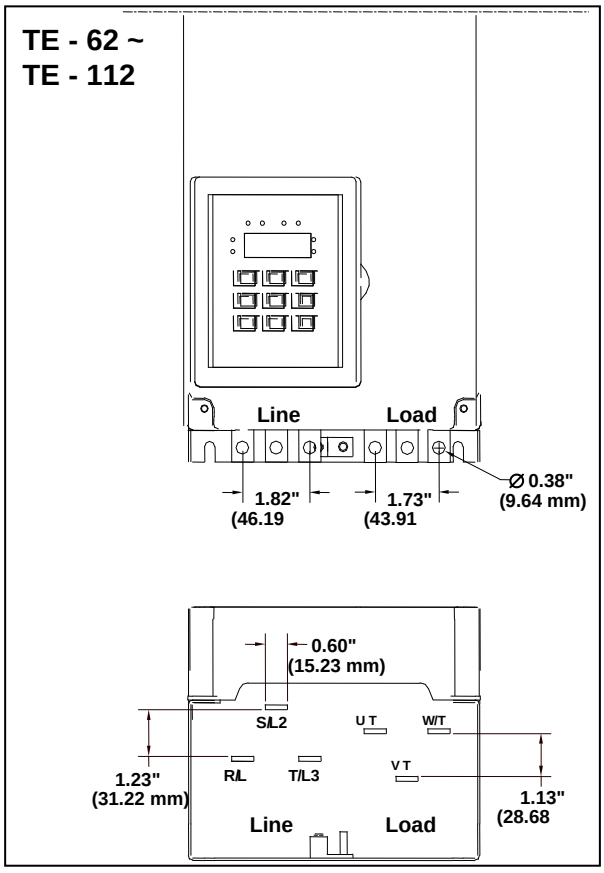


Figure 2.6.2 Critical clearances for bus tab connections

2.6 Power Connections (cont.)

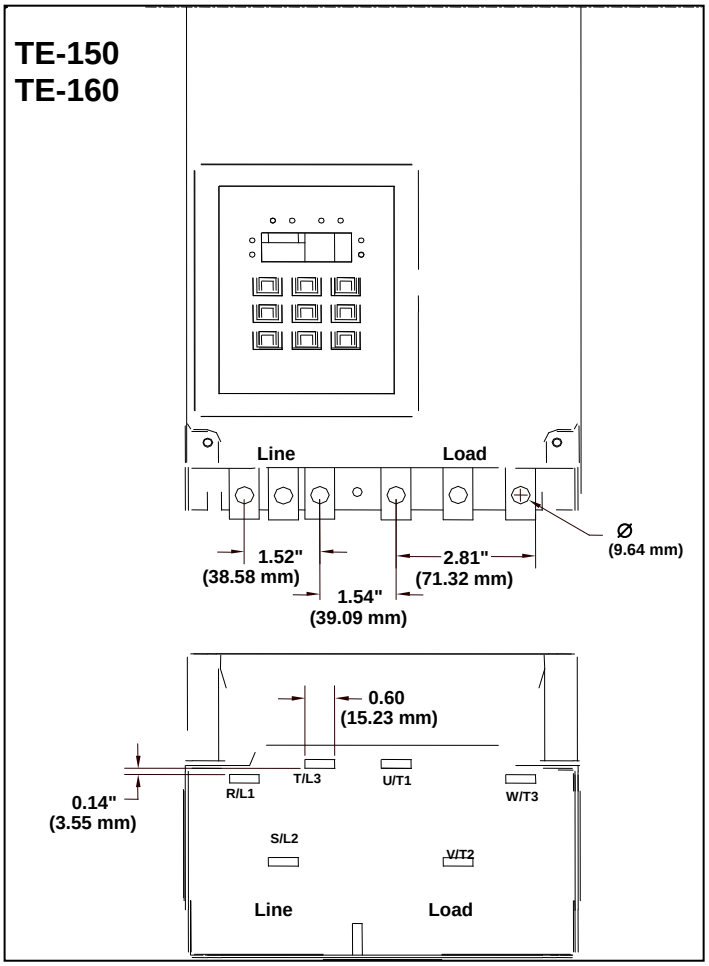


Figure 2.6.3 Critical clearances for bus tab connections

NOTE: Consult factory for bus tab critical dimensions for units 210A and above

2.6.1 Power Terminals:

Connection points for units of 160A and below are saddle clamps suitable for stranded wire. Connection points for units of 210A and above are bus tabs with pre-drilled holes (see below). Use appropriate compression or mechanical lugs for termination to these bus tabs.

Suggested wire sizes and tightening torques for factory-supplied connectors when using conductors rated for 75°C are shown in the chart below. Always consult local codes and industry standard practices for proper wires sizes to accommodate voltage drop and ambient conditions.

Model Number	Current Range Min.- Max.	Suggested Wire Size AWG	Tightening Torque in.-lbs.	Screw / Bolt Size	Tightening Torque Nm	Suggested Wire Size ISOmm^2
TE-18-BP	9 - 18	12	35	1 x M5 (included)	4	6
TE-28-BP	14 - 28	10				10
TE-39-BP	19 - 39	8				16
TE-48-BP	24 - 48	6				16
TE-62-BP	36 - 62	4	45	1 x M8 (included)	5	25
TE-78-BP	39 - 78	3				35
TE-92-BP	46 - 92	2				35
TE-112-BP	56 - 112	2				50
TE-150-BP	75 - 150	0	80	1 x M8 (included)	9	70
TE-160-BP	80 - 160	2/0				70
TE-210-BP or -P	105 - 210	4/0	200	1 x 0.38" hole (M10) for User supplied lugs	15	120
TE-276-BP or -P	138 - 276	300 kCMIL				150
TE-360-BP or -P	180 - 360	500 kCMIL				300
TE-450-BP or -P	225 - 450	2 x 250 kCMIL				2 x 150
TE-550-BP or -P	275 - 550	2 x 250 kCMIL				2 x 150
TE-718-BP or -P	356 – 718	CF	CF	CF	CF	CF
TE-900-BP or -P	450 – 900	CF	CF	CF	CF	CF
TE-1000-BP or -P	50 - 1000	CF	CF	CF	CF	CF

Table 2.6: TE Series Wire Ranges and Torque Specifications
CF = Consult Factory

2.7 Remote Keypad Mounting

The keypad / operator interface unit can be remotely mounted up to 10' (3 meters) away from the starter, i.e. on the enclosure door. A remote mounting kit is necessary, consisting of an adaptor plate, a doorframe for NEMA 1 or NEMA 12 enclosures and a pre-assembled ribbon cable available in 1-meter length increments. Detailed assembly instructions and an enclosure cutout template are included with that kit. See Product Selection Guide for part numbers of the different kits depending on NEMA rating and cable lengths.

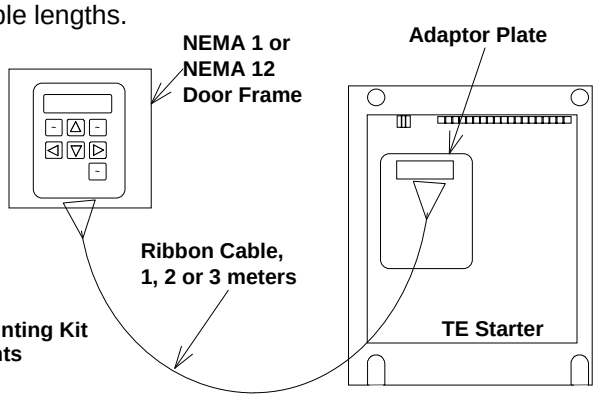


Figure 2.7
Remote Keypad Mounting Kit Components

2.8 **Dimensions** (consult price catalog for enclosed units)

Enclosure	Model Number	Overall			Mounting		
		A	B	C	D	E	F
Panel (open) with integral bypass contactor	**TE -18-BP thru TE -48-BP**	8.75	7.95	6.66	7.56	7.00	0.22
	TE -62-BP thru TE -112-BP	14.00	8.00	6.68	12.75	6.75	0.28
	TE -150-BP and **TE -160-BP**	19.21	8.00	6.68	18.25	6.75	0.38
	TE -210-BP thru TE -450-BP	28.5	12.5	9.1	27.38	10.75	0.40
	TE-550-BP thru TE-600-PB	28.50	12.5	9.10	27.38	10.75	0.40
	TE-862-BP thru TE-900-BP	43.13	25.5	11.86	43.00	23.00	
	TE-1006-BP thru TE-1250-BP	46.56	28.2	13.00	42.75	23.25	0.50

Table 2.8: TE Dimensions (subject to change)

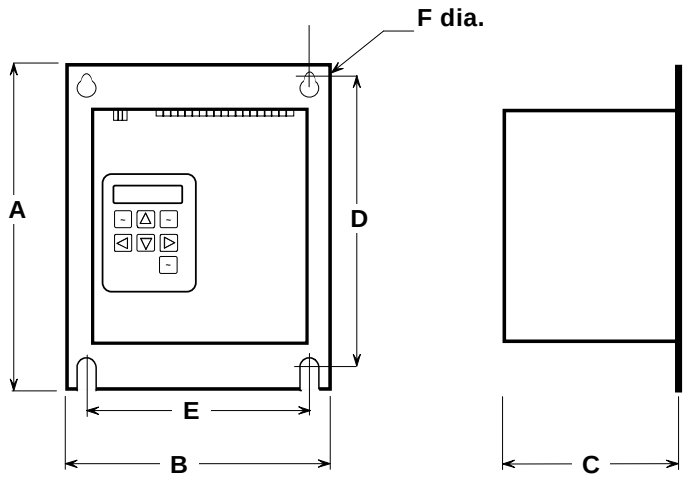


Figure 2.8: TE Dimensions

Chapter 3 - Motor Overload Protection

MOTOR FLA (F001) must be programmed for unit to operate!

3.1 Solid State Overload Protection

The ***TE Series*** Starter provides true U.L. listed I^2t Thermal Overload Protection as a built-in function of the main digital processor for maximum motor protection. It simulates the tripping action of a bi-metallic overload relay, with the accuracy and repeatability of a digital control system. It is adjustable over a wide range and can be easily programmed for different trip curves.

3.1.1 Thermal Memory

The ***TE Series*** microprocessor uses a sophisticated "Thermal Register" in the digital memory to keep track of motor heating and cooling over time regardless of the starter's power status. By using non-volatile memory, the ***TE Series*** does not "forget" that the motor has been running even if power to the starter is turned off and turned back on. Continuous overload protection is provided based on the true thermal condition of the motor.

3.1.2 Thermal Capacity

The Thermal Register is displayed as a percentage. This percentage is the motor's remaining thermal capacity. The percentage value begins at 100, showing that the motor is cool (has 100% of its capacity available). As the motor heats up or moves toward an overload condition, the percentage begins to drop. The Thermal Capacity is derived from the programmed motor nameplate Full Load Amps (FLA) in Function F001, the Service Factor rating in Function F002, and the Overload Trip Class in Functions F003 and F004. Setting these functions to the proper values provides maximum protection and eliminates nuisance tripping.

Examples:

100% Thermal Capacity remaining at rest

57% Thermal Capacity remaining after starting (43% used)

The Remaining Thermal Capacity can be viewed by using the UP or DOWN arrow keys when in the Status Display mode. From the default Phase A Current screen (dot on right side), press the UP arrow key 4 times to display **[H100]** meaning there is 100% of the Thermal Capacity (H = Heat capacity) remaining in the motor. After starting or running, the motor will use this capacity and the display will show a lower number. For example, after a cold start, the display may read **[H065]** which indicates that the motor has 65% of its thermal capacity remaining (35% used). The Status Display screens cycle back to the beginning, so the Down arrow keys can get to this display as well.

- **3.1.2.a Motor Full Load (FLA) Setting**
  Use Function F001 to enter motor FLA as indicated on the motor nameplate. (Do not calculate for service factor, this is programmed separately in F002).

- **NOTE:**
  All ***TE Series*** starters are shipped from the factory with F001 set to a default value of 0000. If F001 is left at the factory default, the unit will not operate. If the user attempts to start the ***TE Series*** without entering the motor nameplate FLA, the starter will Fault and the display will read "**nFLA**" (no Full Load Amps).

3.1.3 Disabling the Overload Protection

The Overload Protection feature can be disabled if necessary. When using external devices such as Motor Protection Relays or when the ***TE Series*** is wired downstream from an existing starter, this feature can be disabled to prevent conflicts with external overload protection devices. When the ***TE Series*** is controlling multiple motors, the built-in Overload protection must be disabled and individual thermal overload relays must be installed on the motor leads going to each motor (see appendix 5 for additional details). To disable the Overload Protection function, use F005.

⚠WARNING

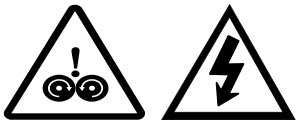
Do NOT disable Overload Protection unless another Thermal Overload Protection device exists in the circuit for all three phases. Running a motor without Overload Protection presents serious risk of motor damage or fire.

- **3.1.3.a Manual Reset**
  The factory default setting is Manual Reset. This means that when the Overload Trip is activated, the starter cannot be restarted without pressing the Reset key. The Overload Trip will not reset until the motor cools down (see 3.1.3.d). The Manual Reset function is also "trip free". Holding in the Reset key will not prevent the Overload Trip from activating and protecting the motor.

- **NOTE:**
  When the Overload Trip activates, the Overload LED will glow solid. When the motor cools down, the LED will begin to flash, indicating that the Overload Trip can be reset.

- **3.1.3.b Automatic Reset**
  If Automatic Reset is necessary, change from Manual Reset to Automatic Reset by using Function F005. (See Section 5 for details). In this mode, a 3-wire control circuit will be capable of restart when the ***TE Series*** has reset itself after the cool down period.

⚠WARNING



Two-wire control systems may restart without warning when Auto Reset of the overload protection is selected. Extreme caution should be exercised. To prevent automatic restarting with 2-wire control systems, use external interlocking to provide sufficient warning and safety to operators. A Warning Label similar to that shown below (and the one provided in the packet with this manual) must be located where visible (on the starter enclosure and/or the driven equipment) as required by local code.

WARNING: MOTOR CONNECTED TO THIS EQUIPMENT MAY START AUTOMATICALLY WITHOUT WARNING

- **3.1.3.c Overload Protection During Bypass**
  When an integral Bypass Contactor is used to shunt power around the SCRs in the ***TE Series*** (as in the TE…-BP version), overload protection is maintained as long as the ***TE Series*** is directly controlling the contactor. No additional Overload Relay is **necessary for normal operation.**

⚠CAUTION
If a Bypass Contactor is added by the user in the field (i.e. 210A units and above), care must be taken to ensure proper power routing to ensure functioning of the Overload protection. Consult factory for assistance.

- When the Bypass Contactor on a ***TE…-BP Series*** has been selected to be used for Across-the-Line restart (reference section 1.2.3), supplemental overload protection may be necessary. For this application, refer to the External Overload Relay Applications supplement and wiring diagram in Appendix 5 and section 4.2.6.a.

- **3.1.3.d Dynamic Reset Capacity**
  The ***TE Series*** includes the ability to dynamically track the Thermal Capacity needed for a successful restart after an overload trip. It averages the Thermal Capacity consumed in the previous three successful starts, and calculates a Thermal Capacity to Start (viewed in Function **F059**). After tripping on Overload, the Thermal Register must have regained the amount recorded in F059 before a Reset will be allowed. If the display reads **[Inh]** when attempting to reset an overload trip, it is indicating that the starter is **Inh**ibited from being reset.

  Refer to details of Function F071 for information on emergency override of lockouts such as this.

3.2 NEMA Class Trip Curves

NEMA Class trip curves are based on a common tripping point of 600% of motor Full Load Amps (FLA). Curves vary by the amount of time before the unit trips. As an example, a Class 20 curve will trip in 20 seconds at 600% of FLA. The factory default setting of Class 10 will trip in 10 seconds at 600% of FLA.

3.2.1 Dual Overload Trip Curves

The ***TE Series*** Soft Starter provides two separate Overload Trip Protection Curves, one for starting and one for running conditions. The starter's At-Speed detection circuit determines when the motor has reached full speed. When the At-Speed condition is reached, the overload trip curve will shift from the Start to the Run level, as programmed in Functions F003 and F004. See Section 5.6.1 for programming details.

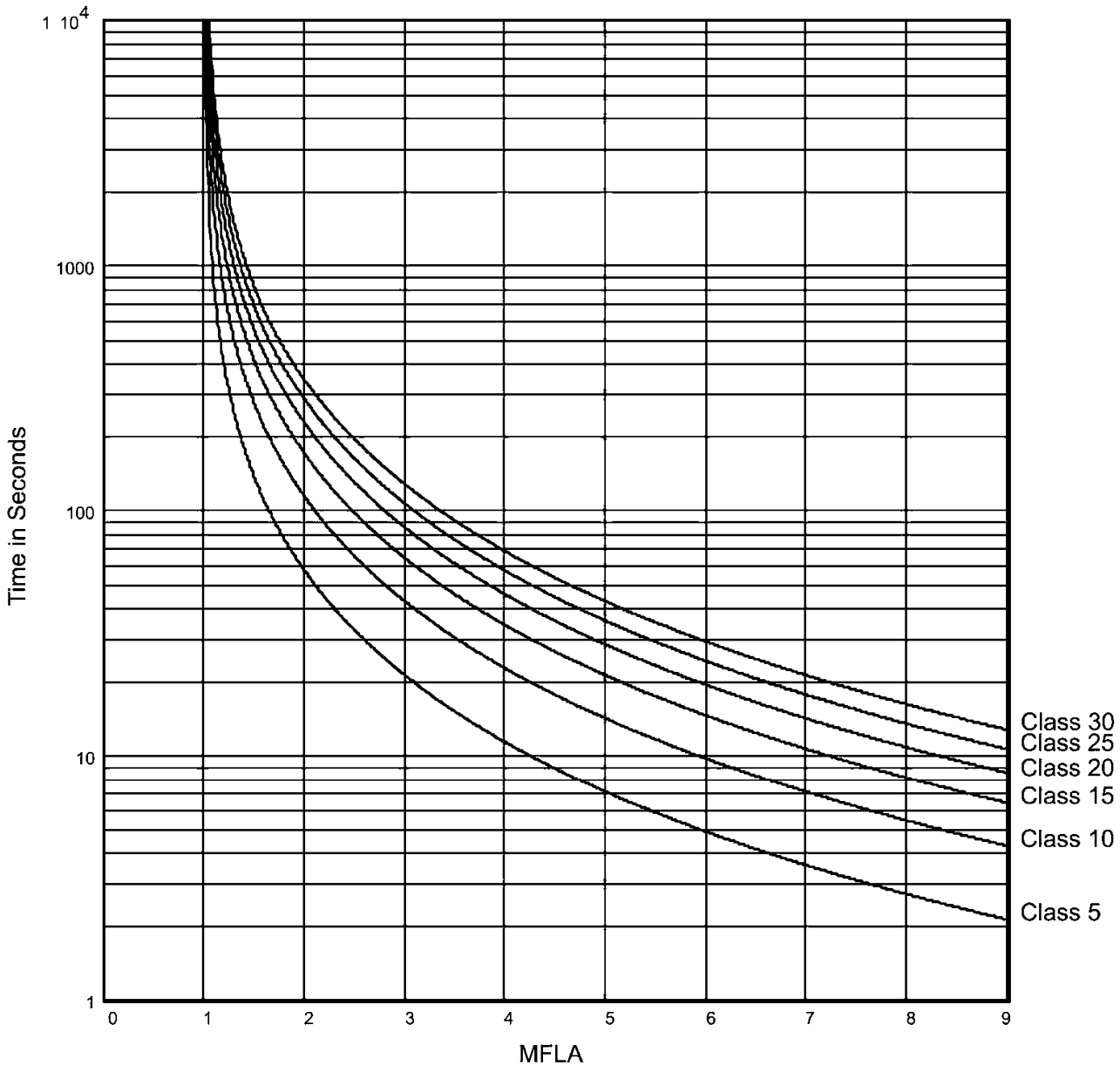
3.2.2 Starting Overload Trip Curve

During the start mode, Overload Trip Curves are selectable from NEMA Class 5 through Class 20 only. The default setting of Class 10 allows protection for the overload capacity of the soft starter as well as the motor. Use a higher Trip Class only if nuisance tripping occurs with the default setting.

3.2.3 Running Overload Curve

During the Run mode, Overload trip curves are selectable from NEMA Class 5, 10, 15, 20, 25, and 30. Program the appropriate curve according to the characteristics of your motor and load.

3.2.4 Overload Trip Curve Chart



Note: Factory default setting is Class 10 for both Start and Run Overload Protection

Figure 3.2.4: *TE Series* Overload Trip Curves

Chapter 4 – Connections

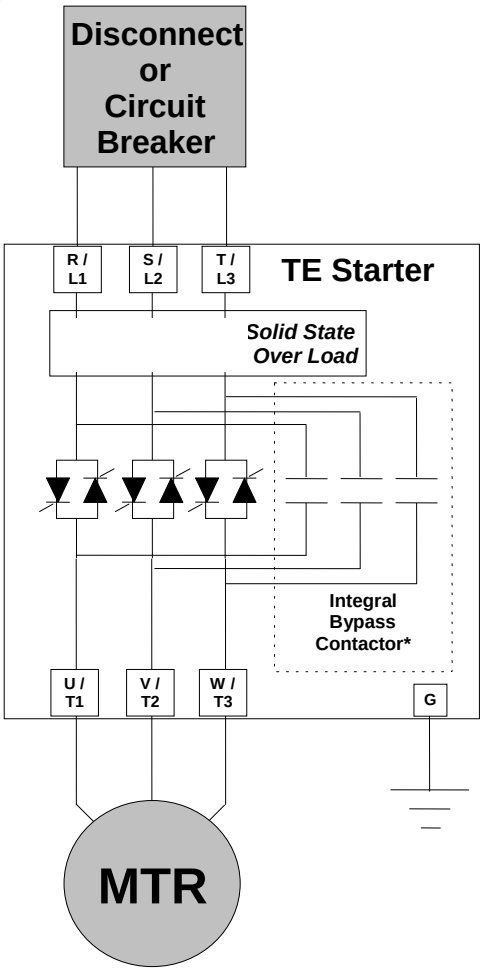


Figure 4.1:
TE Power Connections

***Larger units (210A and above) can be ordered with fan cooling instead of Bypass Contactors, but are intended for use in NEMA 1 ventilated enclosures only. Do not use the TE starter in a sealed enclosure without a bypass contactor.*

4.1 Power Connections

Connect appropriately sized power conductors to the unit input terminals marked L1, L2, L3 (R, S, T for IEC users). Connection points for units of 160A and below are saddle clamps suitable for stranded wire. Connection points for units of 210A and above are bus tabs with pre-drilled holes (see section 2). Use appropriate compression or mechanical lugs for termination to these bus tabs. Avoid routing power wires over the control board or display. Connect the motor leads to the unit terminals marked T1, T2, T3 (U, V, W for IEC users). Refer to local code standards for wire sizing and length.

If control power is present, but line power is disconnected from L1, L2, L3, the display will show **[n3PH]** indicating "no 3 Phase".

⚠CAUTION

Never interchange input and output connections to the unit. This could cause excessive voltage in the control logic circuit and may damage the unit.

4.1.1 Bypass Contactor

Bypass Contactors are integral (built-in) on all TE…-BP (panel mount), and all TE…–E (NEMA 12 enclosed) versions. See sections 3.2.1.c and 4.2.5 for more details on contactor control and overload protection details.

4.1.2 Power Factor Correction Capacitors

Power factor correction capacitors can be connected to motors controlled by ***TE Series*** starters, however they must be off-line during ramping. Connect PFC capacitors to the Line side of the starter with a separate capacitor control contactor.

⚠WARNING

Never connect power factor correction capacitors on the load side of the unit. The SCRs will be seriously damaged if capacitors are located on the load side.

4.1.3 Grounding

Connect the ground cable to the ground terminal as labeled on the unit. Refer to the National Electrical Code or your local Code for the proper ground wire sizing and be sure that the ground connector is connected to earth ground. In ungrounded systems, it is not necessary to connect a ground to the unit however local codes should always be consulted.

4.1.4 Testing

The ***TE Series*** can be tested with a load smaller than the motor it was originally selected to control, however additional steps must be taken to avoid tripping on Phase Current Loss. See section 5.6.9.a under "Phase Loss Protection" for additional details on performing this task.

- **NOTE:**
  The unit cannot be tested without a motor or other test load connected to the load side of the unit. It may be necessary to use a load bank to test the unit without a motor.
- Line voltage will appear across the output terminals if there is no motor or load connected to the unit.
- IMPORTANT NOTE:
  Fault code SSd may display if there is no output load connection when control power is applied!

4.1.5 Lightning Protection

As with all electronic power controllers, protection from damage by lightning surges is recommended in areas where lightning is a significant problem. Stationary air gap lightning arrestors should be considered and utilized on the input power source. The best method of protection is to have an Isolation Contactor in front of the starter that is open when the soft starter is not in use.

4.2 Control Connections

Control connections on the ***TE Series*** starter are divided into 2 groups. With the unit oriented vertically, TB1 is a 12-point DC terminal block (on the left), and TB2 is a 10 point AC terminal block (on the right side). These are removable terminal blocks for ease of connection and servicing, and are provided with different spacing (pitch) between the header pins so they are not interchangeable. Following are descriptions of control connection points.

- **NOTE:**
  Terminal numbers are shown on the side of the first and last terminal of each block. An additional 3 point terminal on the far left side is for serial communication connections (see section 5.6.11).

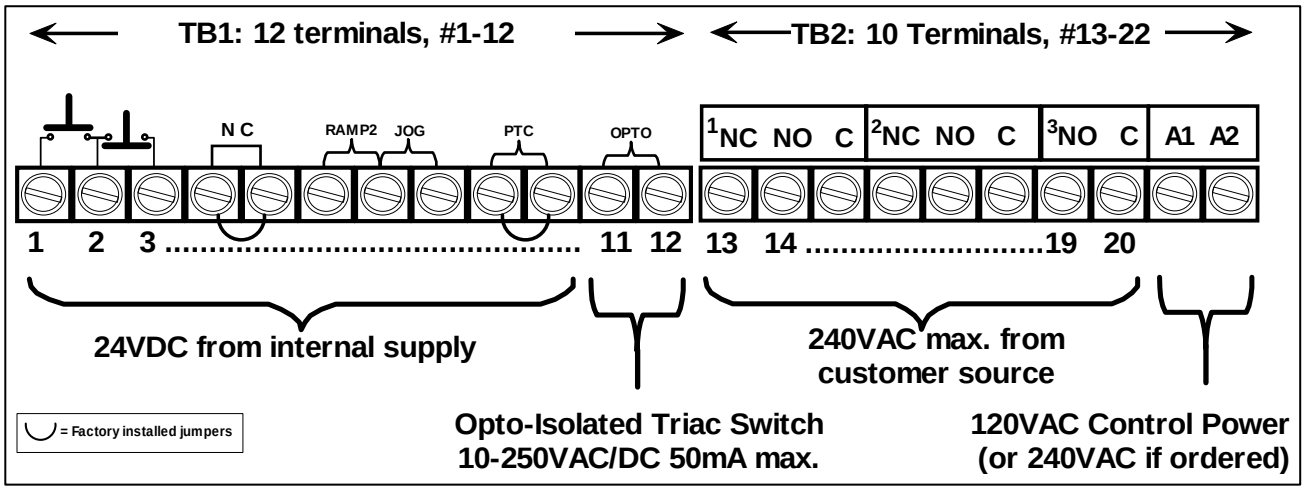


Figure 4.2: Control Terminal Blocks

4.2.1 AC Control Power Supply Connection

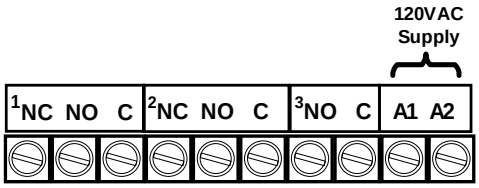


Figure 4.2.1
Control Power Supply Connection
TB-2

Separate AC Control Power supply is required to power the electronics of the ***TE Series*** starter. 120VAC is standard, order 240 VAC (optional) if necessary for your line power supply configuration. The control voltage must be connected to terminals marked A1 and A2 of TB-2 as shown in figure 4.2.1 (these are also Terminal #s 21 and 22). This control voltage must be customer supplied, unless an optional control power transformer (see table below) has been supplied with the unit.

AC Control Power VA Requirements					
TE …-BP Model	**PC Boards**	**Fans**	**-BP: Bypass Contactor Inrush**	**-BP: Bypass Contactor Sealed**	**Recommended minimum CPT Rating**
TE-18 to 48	48	(inc. in PCB)	95	9	100
TE-62 to 112	48	(inc. in PCB)	220	17	250
TE-150 to 160	48	72	298	12.3	500
TE- 210 to 276*	48	100	380	11.6	500
TE-360 to 450*	48	150	571	14	750
TE-550 to 900*	48	200	600	3.3	750
TE-1006 to 1250*	48	200	1900	48	2000

Table 3: ***TE Series*** Control Power Requirements
NOTE: * - P versions (w/o bypass) still require PCB and fans, plus user supplied bypass (if any).

- **4**

.2.1.a Control Power Requirements

When sizing a control power transformer for the ***TE…-BP Series*** starter use the above chart for minimum sizes or supply capacity. Any additional control devices powered by the same CPT must be added to the above figures to ensure proper operation of the Bypass Contactor.

- **NOTE:**
  TE-210 and larger units are available without the Bypass Contactor, but fans are still included. CPT can be sized for fan loads only if used in NEMA 1 ventilated enclosures.

- **4.2.1.b Control Fusing**
  Output relays in TB2 must be protected from currents in excess of 5A, either with a fuse or with other suitable current protection devices.
- A dedicated fault output for use in PLC or interposing relay control is available on TB1. This opto-isolated Triac switch is rated for 50mA max., 10-250V AC/DC. Any circuit connected to it must be fused accordingly.

4.2.2 Three-Wire Control Connection

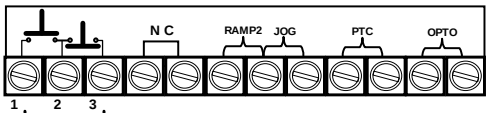


Figure 4.2.2
3 Wire Control Connection
TB-1

For standard 3-wire control, connect dry (voltage free) contacts of the Stop / Start buttons as shown on the diagram directly above the terminal strip. Connect the NO contact of the Start button to Terminal #1 (far left terminal), the common point between the Stop and Start to Terminal #2 (2nd from left) and the NC from the Stop button to Terminal #3 (3rd from left).

- **4.2.2.a Seal In Contact**
  The ***TE Series*** uses an internally pre-wired "seal-in" contact around the Start button (Terminals 1 and 2). No external relay or auxiliary output connection is necessary**.**

4.2.3 Two Wire Control: Relay / PLC Connection

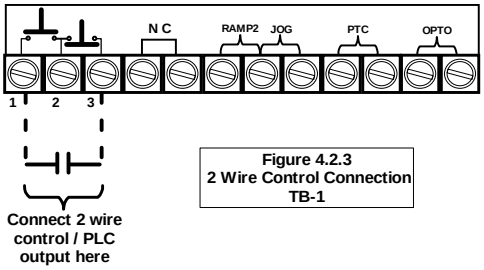


Figure 4.2.3
2 Wire Control Connection
TB-1

An alternate connection for automated or unattended operation replaces start/stop push buttons by connecting a dry (voltage free) maintained contact closure between terminals 1 and 3 as shown in Figure 4.2.3. When this contact is closed, the ***TE Series*** starter will start and run. When it is opened, it is the same as a Stop command.

- **4.2.3.a Automatic Functions and 2 Wire Control**
  If using the Time Clock functions (F032-F039) or Auto Reset functions (F052 – F053), special consideration must be given to using 2 wire control. Refer to Appendix 3 for additional details and information on time clock functions, and section 5.6.9 for details on using Auto-Reset functions.

- **NOTE:**
  When a maintained contact is used for start/stop it is advisable to set the overload relay to the manual reset position. This will prevent the motor from restarting if the thermal overload trips and then cools off.

⚠CAUTION

Control Terminals 1-10 of TB1 are a 24VDC circuit from an internal power supply of the *TE Series*.

Use dry (unpowered) contact closures only. Applying any voltage to these terminals will result in damage to the *TE Series* control board.

If existing 120VAC or other powered control circuit must be interfaced, use interposing relays or control the *TE Series* with 2 wire control as shown above.

4.2.4 Interlock Connection

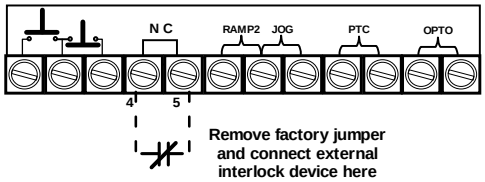


Figure 4.2.
External Interlock Connection
TB-1

TB1 provides a connection point for an external dry (voltage free) N.C. (Normally Closed) interlock device between terminals 4 and 5. Examples where this interlock connection would be used include low oil, high temperature, or excess vibration dropout from user supplied devices. A factory-installed jumper is provided which allows the ***TE Series*** unit to operate if external interlocks are not used. If this jumper is removed and an interlock is <u>not</u> used, the ***TE Series*** unit will not function.

4.2.5 Enabling the Dual Ramp and Jog Features

TB1 includes provisions for enabling the Dual Ramp and Jog functions by using external contact closures. Both features use a common +24VDC from Terminal # 7, however they can be used independently of each other or together. See sections 5.6.2 and 5.6.3 for full function descriptions and setup.

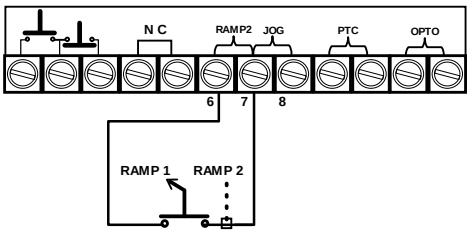


Figure 4.2.5.a: Dual Ramp Connections TB-1

- **4.2.5.a Dual Ramp Command**

  Closing a dry (voltage free) contact between TB1, terminals 6 and 7 will enable Ramp 2, and the ***TE Series*** starter will respond to the settings for Ramp 2 in F015 - F018. If no contact closure is present, the ***TE Series*** starter defaults to the Ramp 1 parameters (F011 – F014). See Section 5.6.2.a for setup of the Dual Ramp Feature.

  The Dual Ramp feature is useful in instances where the load changes significantly. Example: a loaded or unloaded conveyor belt. The characteristics for starting an unloaded conveyor can be programmed for ramp 1. The characteristics for starting a loaded conveyor can be programmed for ramp 2. Ramp 2 can also be programmed for Full Voltage / Across-the-Line starting by setting the ramp time to 0 and Current to 600%.

  Dual Ramp is also useful in 2-speed motor applications. Simply use an auxiliary contact from one of the speed contactors to select Ramp 2 so that separate ramp profiles can be used.

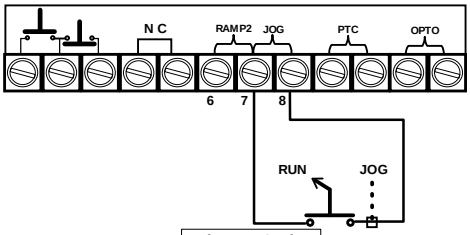


Figure 4.2.5.b: Jog Connections TB-1

- **4.2.5.b Jog / Remote Command**

  Connecting a dry (voltage free) contact between TB1, Terminals 7 and 8 will enable the Jog feature. A Start command (Run Command or Start button) is required to activate the Jog feature. See Section 5.6.3 for setup of the Jog Function.

  The Jog feature can be used for tasks such as lining up machines for blade or bit changes or inching belts along to check tracking.

  This input is also used to change the function of the Serial Communications port control through **F068**. For additional information, see instructions of that function in **section 5.6.11**.

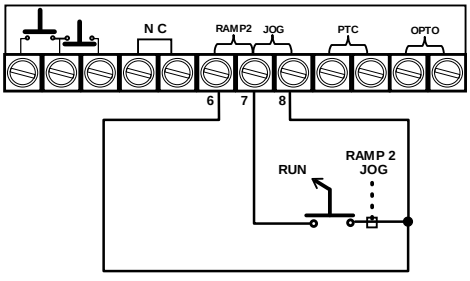


Figure 4.2.5.c: Dual Ramp / Jog Connections TB-1

- **4.2.5.c Using Both Commands**

  It may be useful to initialize the Ramp 2 and Jog command simultaneously when jogging. If this is the case, terminals 6 and 8 can be jumped together and controlled with one contact closure to Terminal 7 (the common 24VDC).

4.2.6 PTC Thermistor Input

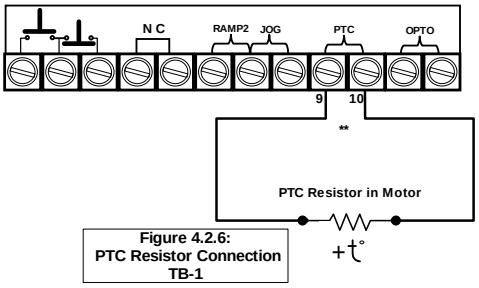


Figure 4.2.6:
PTC Resistor Connection
TB-1

** Remove factory jumper from Terminals 9 and 10

The ***TE Series*** starter is provided with input terminals for connecting a PTC (Positive Temperature Coefficient) Thermistor that may be imbedded in the motor. These are specialized resistors imbedded in some motor windings that increase resistance as the temperature increases. When the ***TE Series*** detects that the PTC input resistance is too high, it initiates a PTC trip, and displays it on the readout as **[PTc]**. This is independent of the Thermal Register overload current protection and provides supplemental protection for high motor ambient temperature applications. Terminals for this input are provided with a factory jumper that must be removed if the PTC input is used. These terminals are located on TB1, Terminals 9 and 10.

PTC resistors are also found in other devices such as bearings, air receivers, oil or coolant reservoirs and air discharge systems that may require shutdown of the motor.

PTC Resistor Values:

Resistance must be greater than or equal to 750 Ω at 25ºC. If multiple resistors are used in the motor, the sum of all resistors in series must equal or exceed this value.

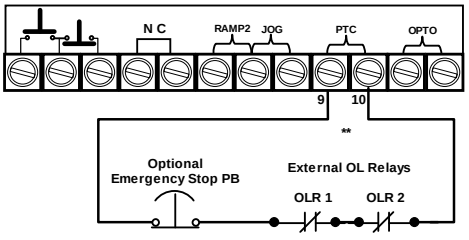


Figure 4.2.6.a:
External Overload Relay(s) and/or E-Stop PB Connection
TB-1

** Remove factory jumper from Terminals 9 and 10

- **4.2.6.a External Over Load Relay Connection**
  If an external Over Load Relay (OLR) is used (see Section 3.1.3.c and Appendix 5), connect the NC aux. contact of the OLR to the PTC input after removing the jumper. When the external OLR trips, the contact will open, opening the resistance input to the PTC circuit (the resistance goes to infinity). This indicates an immediate Over Load to the starter, which trips and displays it on the readout as
- **[PTc]** to differentiate from the internal Thermal Over Load trip. If multiple OLRs are used, i.e. multiple motors controlled by the same ***TE Series*** starter, simply wire the Aux Contacts in series as shown in Figure 4.2.6.a. See Appendix 5 for additional information.

- **NOTE:**
  An Emergency Stop Push Button or any other field device may be wired to the PTC input using NC contacts. When the contacts open, the starter will detect it as a PTC trip. Even if a PTC is used in the motor, field devices can still be added as long as the total circuit resistance is not exceeded.
- This feature is especially useful when using Decel Control because it will immediately shut off power to the motor even if Decel is active. If used this way, instruct the users as to the trip indication issues (i.e. the display will show **[PTc]** and the Overload LED will be on).

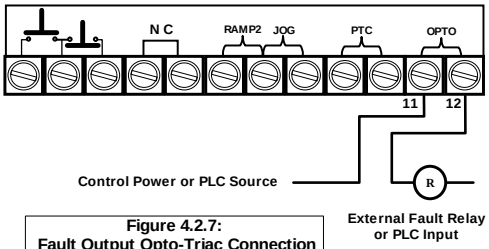


Figure 4.2.7:
Fault Output Opto-Triac Connection
TB-1

4.2.7 Fault Signal

An optically isolated Triac output is dedicated as a fault indicator on TB1, terminals 11 and 12, labeled "**Opto**". The output Triac switch is rated for 10 - 250 VAC/DC, **50 mA (maximum)**. If the three programmable Output Auxiliary Relays are being used for other functions, this output can easily be hooked up to a PLC or small external relay to provide a Fault signal. This Fault Output operation is permanently fixed at "Any Trip", duplicating the Relay setting #16 as shown in Table 5.6.10.

This output is permanently set to this function and is not programmable.

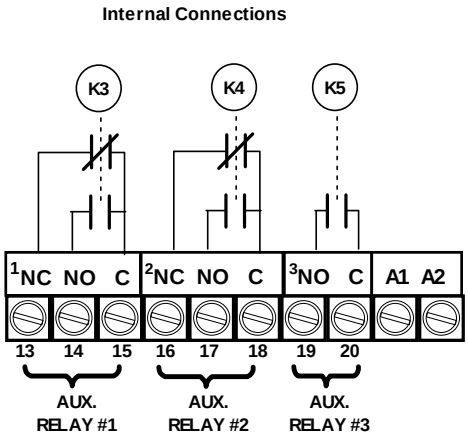


Figure 4.2.8
Auxiliary Relay Connections
TB-2

4.2.8 Output (Auxiliary) Relay Contacts

Three programmable auxiliary relays are on TB2. The ***TE Series*** starter comes with three programmable dry relay output contacts. Outputs #1 and #2 are Form C (SPDT), with a Common, N.O. and N.C. Output #3 is a Form A, (SPST), N.O. contact. It is not necessary to use the programmable output auxiliary relays in the Start / Stop circuit. An internal seal-in relay is provided elsewhere (see 4.2.2.a above). Toshiba recommends fusing all contacts with external fuses.

The relays are rated for 240 VAC, 5 A and 1200 VA.

Factory default settings for these relays are as follows:

- **AUX 1** – Run / Stop (see F060) This contact changes state upon a Start command, returns to normal on Stop (or Begin Decel if active).
- **AUX 2** – At-Speed / Stop (see F061) This contact changes state upon the ***TE Series*** detecting At-Speed, and returns to normal on Stop. At-Speed is determined by the ***TE Series*** detecting the current dropping after reaching End-of-Ramp, or a maximum of 30 seconds after Start.
- **AUX 3** – Any Trip (see F062) This contact closes when any trip condition # 5 – 15 (as defined in Table 5.6.10) occurs.

All relays can be reprogrammed for a wide variety of functions. See Section 5.6.10 for additional relay programming details.

4.2.9 Bypass Contactor Control

On **TE…-BP** version (and NEMA 12 enclosed) starters, an internal dedicated connection is used at the factory for automatically controlling the Bypass Contactor. Field wiring for Bypass Contactor operation is not required.

- **4.2.9.a Independent Bypass Contactor Control**
  The ***TE…-BP Series*** starters use standard industrial contactors that can be controlled independent of the starter electronics if necessary. When doing so, it is necessary to size the starter based upon the ATL (Across-the-Line) selection chart so that the contactors are rated for ATL duty instead of the normal Shunt Duty (see section 1.2.3). Supplemental overload protection will be required (see section 3.1.3.c).

  Units have external terminal blocks marked for this purpose (see Appendix 5 for drawings). A dry (voltage free) contact closure between these terminals will close the bypass contactor immediately. The Bypass Contactor coil voltage is the same as the control voltage (120VAC unless the optional 240VAC control is specified), and the potential on these terminals is the same as the coil voltage.

  No field wiring is necessary to these terminals if this feature is not used.

For all other styles of ***TE Series,*** the At-Speed signaling can be programmed into any of the three Output relays above (section 4.2.8 and Table 5.6.10).

Chapter 5 - Programming

MOTOR FLA (F001) must be programmed for unit to operate!

5.1 Introduction

It is best to operate the motor at its full load starting conditions to achieve the proper time, torque and ramp settings. Initial factory settings are set to accommodate general motor applications and provide basic motor protection. Advanced features must be enabled via programming. The only parameter that MUST be set by the user is motor FLA (F001).

5.2 Digital Interface

The ***TE Series*** Soft Starter includes an intuitive, digital keypad with eight LEDs, seven command keys, and an LED display with four alphanumeric digits.

Figure 5.2: Digital Interface

Keys	Reset	Clears the Trip indication and releases the Trip Relay.
	Fn	Enters or exits the Program Mode.
	Up and Down Arrows	Navigates through the Status Display Mode, scrolls up and down through the Function List, increases or decreases the value of the active (flashing) digit and scrolls through the fault history. When entering values, holding the key down for more than 2 seconds will activate Auto-step, which increases its rate the longer the key is held down.
	Right and Left Arrows	Each key press shifts the active (flashing) digit to the right or left by one position, allowing you to change higher values of functions without waiting to Auto-step though large numbers.
Green LEDs	Power On	Control power is available at A1 and A2
	At Speed	The motor is at full power and the Bypass Contactor has been commanded to pull in. The SCRs are at full conduction and current has dropped.
Yellow LEDs	Shunt Trip	Two or more SCRs in opposing phases have shorted, and power is flowing to the motor in the Off mode. See section 8 for additional concerns.
	Shorted SCR	There is no voltage drop across at least one SCR phase assembly, indicating that at least one SCR is shorted. See section 8 for additional concerns
	Over Current	Overcurrent LED lights for three sets of fault conditions: 1) During start, the unit saw current exceed the normal rate of increase in the first 250ms. 2) During Run, current exceeded either the OC setting in F042 for the delay set in F043. This LED will be accompanied by oCA, oCC or oCd on the display. 3) The unit has seen a Short Circuit exceeding 10x FLA for 12.5ms. This LED will be accompanied by SCA, SCC or SCD display.
	Phase Loss	One or more of the phase currents dropped below the threshold during starting or running.
	Over Temp	Starter has tripped due to excess heat sink temperature. This will automatically reset.
	Over Load	Starter has tripped due to the Thermal Register reaching 0000. The Overload must reset before this fault can be cleared.
Display	8888.	4 digit 7 segment display with a decimal point on the right side indicating Phase A.

Table 5.2: TE Series Display Features

5.3 Display Modes

There are three modes of display: the Status Display Mode, the Program Mode, and the Fault Mode.

5.3.1 Status Display Mode (Default Display)

The Status Display Mode displays seven "screens" of information. Motor Currents (3 phases), Remaining Thermal Capacity, Ground Current, Remaining Time on the Process Timer, and Time Base of the Time Clock Controller. This is also the entry screen for going into the Program Mode.

Status mode:

[0000.] The initial display on power up is four digits and the decimal. This indicates the motor current for Phase A of the motor.

[0000] Scroll UP to display four digits only (no decimal). This indicates the motor current for Phase B. While viewing Phase B, press the UP arrow again to view Phase C current.

[G000] Scroll UP to display the "G". This indicates that this value is the current flowing to ground on the motor leads.

[H000] Scroll UP to display the "H". This indicates that this value is the remaining thermal capacity percentage of the motor (i.e. H070 = 70% remaining thermal capacity)

[0000] Scroll UP again to display the Process Batch Timer (described in Section 5.6.7). If this entire screen is flashing, the Timer is active.

[00.00] Scroll UP to display two pairs of digits separated by a point: This indicates the time base of the Time Clock Controller (described in section 5.6.7). If the display shows [00.00], the TCC is not enabled. This follows the time settings in F075 – F080.

Example: Figure 5.3.1

Reading the Status Display

[0120.] Indicates Phase A is drawing 120 amps.

Press the UP arrow

[0121] Indicates Phase B is drawing 121 amps. *NOTE: Decimal points are not present in the readouts for Phases B and C*.

Press the UP arrow

[0120] Indicates Phase C is drawing 120 amps.

Press the UP arrow

[G002] Indicates that there are 2 amps of current flowing to ground in the motor leads or motor.

Press the UP arrow

[H083] Indicates the motor has 83% of its thermal capacity remaining (H = Heat).

Press the UP arrow

[0060] Indicates there is 60 minutes remaining on the Process Timer. *If flashing, the timer is active.*

Press the UP arrow

[13.30] Indicates the time base of the Time Clock Controller is 1:30 PM (24hr time). *If flashing, the time clock is active and pending the next event.*

Press the UP arrow

[0120.] Loop back to Phase A current indication

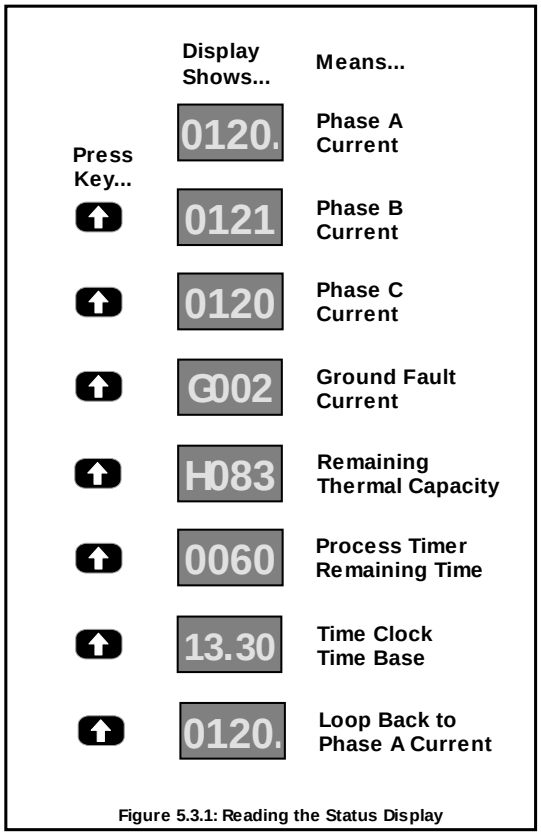


Figure 5.3.1: Reading the Status Display

5.4 Program Mode

The starter must be OFF in order to enter the Program Mode.

Use the Program Mode to view or change Function (Fn) settings. To enter the Program Mode, press the **[Fn]** key once from the Status Screen described in 5.3.1 above. The first time you enter the Program Mode after power has been cycled to the starter, the initial function **[F001]** should display with the selected digit flashing. If the ***TE Series*** starter has been programmed and power to the unit has not been cycled, the readout will display the last function viewed or changed. To change to a different function, use the arrow keys.

5.4.1 Viewing Function Programming and Values

The programming of each individual Function can be viewed without making changes (values can also be viewed in the Run Mode, however no changes can be made). Each Function is signified by the letter “F” in the beginning of the data, the 4 digit value of the function follows after hitting the **[READ/ENTER]** key

- **[F001]** The “F” indicates the programmable **F**unction.
- **[0000]** This is the present setting of the applicable function. This display may include decimals between digits depending on the function setting’s range and incremental steps.

Example: Figure 5.4.1
Viewing a Function’s Set Value:
Motor FLA Setting

[0000.] Indicates that Phase A is drawing no current (unit is in Off mode).

Press the Fn key

[F001] Indicates that this is Function 001 (Motor FLA).

Press Read / Enter key to view the F001’s value

[0306] Indicates that the programmed motor FLA is 360 Amps.

Press the Fn key to return to the function

[F001] Indicates that you have returned to the Function Select screen**.**

Press the Fn key again to return to the Status Display Mode

[0000.] Default screen.

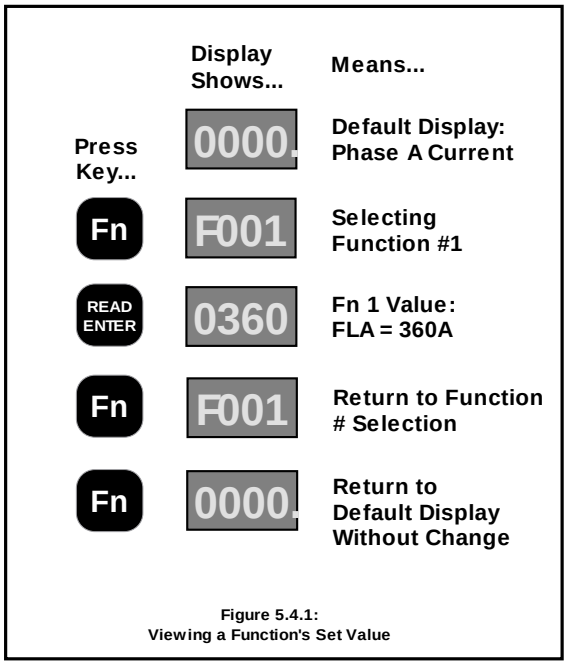


Figure 5.4.1:
Viewing a Function's Set Value

- **NOTE:**
  If password protection has been enabled, operator will need to obtain password access before function settings can be changed. See Section 5.6.12 and Appendix 3.

5.4.2 Enabling Password Protection / Parameter Lock

The ***TE Series*** starter is shipped with the password protection disabled (F070 = 0). If it becomes necessary to prevent parameters from being changed inadvertently, set the password in function F070. See Appendix 3 for details. If the display reads **[Loc]** when the **[READ/ENTER]** key is pressed, the parameter lock is enabled.

5.4.3 Changing a Function's Set Value

From the instructions above, after hitting the **[READ/ENTER]** key the display will show the value of that function with one digit flashing (usually the rightmost digit). Flashing indicates this is the digit to be altered (similar to cursor position). Use the UP arrow key to increment the value of the flashing digit. Use the DOWN arrow key to decrement the value of the flashing digit. Use the LEFT or RIGHT arrow to select the next digit to be altered. Values can only be changed within the Adjustment Range of the function parameter.

Example 1: Figure 5.4.3

Viewing a Function's Set Value

[0000.] Indicates Phase A is drawing no current (unit is in Off mode).

Press the [Fn] key

[F001] Indicates this is Function 001 (Motor FLA).

Press [READ/ENTER] key to view the F001 value

[0048] Indicates the programmed motor FLA is 48 Amps. The farthest left digit (8) is flashing, indicating that this is the digit that you will alter (cursor position).

Press the UP Arrow key to increase this digit value

[0049] Indicates you have increased the left digit to a value of 9**.**

Press the LEFT Arrow key to shift left to the next digit

[0049] The second digit from the left is now flashing, indicating a new cursor position.

Press the UP Arrow key to increase this digit value

[0059] Indicates you have increased the 2nd to left digit to a value of 5 (10's place)**.**

Press [READ/ENTER] key to store the new value

[End] The word "End" will flash briefly to indicate that the new value has been entered and accepted. After flashing once, the display will revert to showing the Function number.

Example 1: Setting the Motor FLA

Change FLA from 48 to 59A

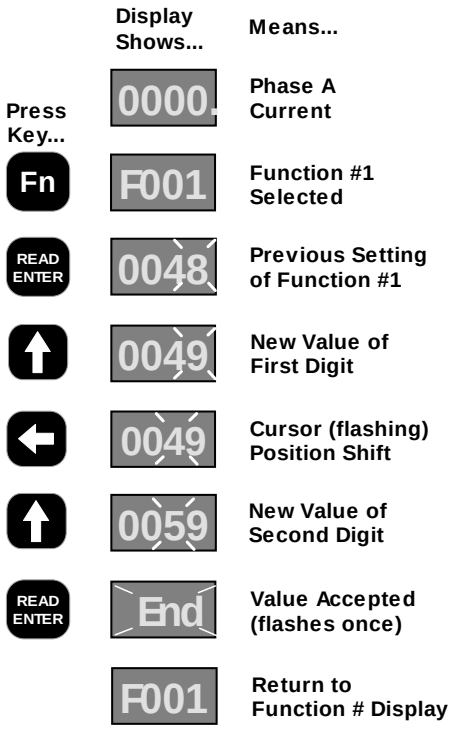


Figure 5.4.3: Changing a Function Value

- **5.4.3.a Changing a Value by Increments**
  Although it may be easier to shift the cursor position, it is also possible to increase or decrease values by pressing the UP or DOWN arrow keys successively. This will change the Function value by the incremental amount associated with that Function. The Function List shows increment values for each Function.

Example 2: Figure 5.4.3.a

Changing a Function's Value by Increments

[0000.] Indicates that Phase A is drawing no current (unit is in Off mode).

Press the [Fn] key

[F001] Indicates that this is Function 001 (Motor FLA). The farthest left digit (1) is flashing, indicating this is the digit that you will alter (cursor position)

Press the UP Arrow key twice to increase this digit value to 3

[F003] Indicates that this is Function 003 (OL Class During Start).

Press [READ/ENTER] key to view the F003 value

[0010] Indicates that the programmed OL is Class 10 during the Start Mode. Cursor flashing on leftmost digit.

Press the UP Arrow key to increase this digit value

[0015] Indicates that you have increased the Function value by the increment assigned to it, a value of 5 in this case**.**

Press the UP Arrow key again to increase this digit value

[0020] Indicates that you have again increased the Function value by the increment assigned to it**.**

Press [READ/ENTER] key to store the new value

[End] The word "End" will flash briefly to indicate that the new value has been entered and accepted. After flashing once, the display will revert to showing the Function number.

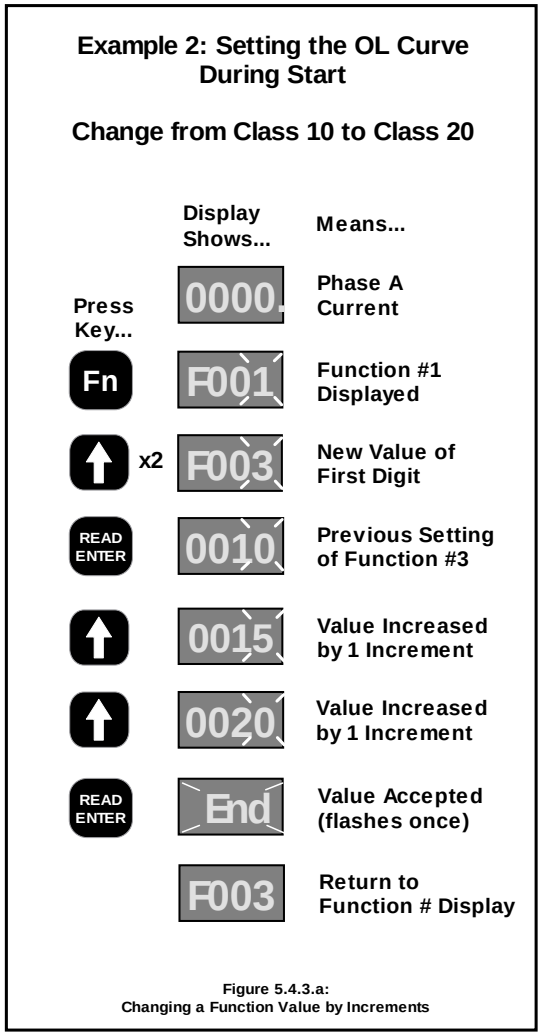


Figure 5.4.3.a:
Changing a Function Value by Increments

5.4.4 Storing the Altered Value of a Function

Once the desired value is displayed, press the **[READ/ENTER]** key. This stores the value in memory. The readout momentarily displays **[End]** and then returns to the function code.

⚠CAUTION

If the Fn key is pressed or power is lost *before* the [READ/ENTER] key is pressed, the *TE Series* Starter will not store the selected value in memory.

5.4.5 Fault Mode

The Fault Mode Display provides information to the operator when a fault occurs and allows the operator to review fault history. Refer to Section 7 for details. Fault codes are three-digits in length and are displayed in alpha characters. The first and second characters (reading left to right) are the initials for the applicable English-language fault name. The third or right-most character can be either A, c, or d to denote when the fault occurred. “A” denotes Acceleration. “c” denotes Constant speed. “d” denotes Decel.

Example: Figure 5.4.5

Viewing a Fault and History

[PLA.] Indicates that there was a Phase Loss during Acceleration. The Decimal point on the right signifies that this is the current fault.

Press the UP Arrow key

[iBc] Displays the previous fault, a Phase Imbalance during Constant Speed (running)

Press the UP Arrow key

[oLc] Displays the oldest fault, an Over Load trip during Constant speed (running).

Press [RESET] key

[rSt] Flashes once to indicate a successful Reset of the current fault. If it cannot be reset, the display will read **[inH]** for Inhibited.

[0000.] Returns to Default Display, indicating that the unit is ready to re-start.

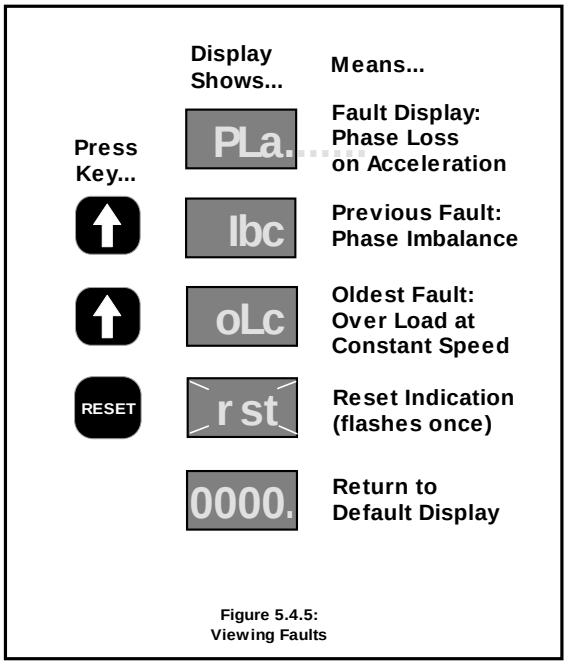


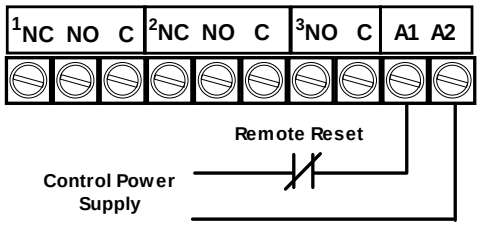
Figure 5.4.5: Viewing Faults

This Fault History can only be accessed during a fault condition. While the active fault number is being displayed, use the Up and Down Arrow keys to scroll through the Fault History. An additional Fault History complete with Time and Date stamps is also available for viewing at any time in F085 through F093.

- **5.4.5.a Resetting Faults**
  Once a fault condition has been corrected, pressing the Reset key will return the readout to the Status Display mode. To reset faults, press the **[RESET]** key on the keypad. Alternatively, most faults will reset upon removal and return of control power. Over Load trips will NOT be reset in this way unless sufficient time has passed for the Thermal Register to regain sufficient capacity for a successful restart (see section 3.1).

- **5.4.5.b Remote Reset**
  Because most trips can be reset by removing control power, remote reset can be accomplished this way. A NC remote contact (or push-button) can be placed in the control power supply to A1 or A2 and opened to facilitate a trip reset. See figure 5.4.5.b for a suggested connection.

Figure 5.4.5.b
Remote Reset Connection
TB-2



- **5.4.5.c Automatic Reset**
  The ***TE Series*** starter provides for automatic reset on certain non-critical faults and Over Load. For non-critical fault resets, see section 5.6.9 for program details of F052 and F053. For automatic Over Load reset, see section 3.1 and 5.6.1 for programming details.

- **5.4.5.d Lockout Functions**
  Lockout functions such as Minimum Time Between Starts and Starts per Hour are not true fault conditions. They are based on the internal Real Time Clock (RTC). When control power is removed, the RTC value is quickly stored. Upon return of power, the timer values are updated from the RTC for elapsed time. If the Lockout Time has not expired, the ***TE Series*** cannot be started. To reset the Lockout Times for emergency restart, see section 5.6.12, under F071.

- **5.4.5.e Changing to Default Screen During Fault**
  In some cases it may be necessary to alter programmed parameters in order to test or make changes to clear a fault (such as Phase Loss) or to view the more detailed fault history in F085 – F097. To accomplish this, you must get to the Status Screen so the Fn button becomes active. When in a Fault Screen, pressing the Right or Left Arrow buttons will take you to the Status Screen. From there, you can hit the **[Fn]** key to enter the Programming Mode and move to different functions.

5.5 The TE Function List

5.5.1 Motor FLA, Service Factor and Overload Protection Functions

Fn #	Group	Function Description	Adjustment / Display Range	Setting Increments	Factory Setting	Section
F001	Motor and Overload Info.	Motor Nameplate FLA FLA must be programmed for starter to function.	50-100% of Max Amp Rating. Upper limit of range automatically adjusts downward as Service factor is increased.	1 amp	0	5.6.1 and 3.2
F002		Motor Nameplate Service Factor	1.00 - 1.30 SF	0.05	1.0 SF	
F003		Overload Class During Start	NEMA / UL Class 5 - 20	5	Class 10	
F004		Overload Class During Run	NEMA / UL Class 5 - 30	5	Class 10	
F005		Overload Reset	0 = Manual 1 = Auto 2 = Disabled Overload	1	0 (Manual)	
F006 - F009		Reserved for factory use				

Table 5.5.1: Motor and Overload Function Group

5.5.2 Starting Mode Functions

Fn #	Group	Function Description	Adjustment / Display Range	Setting Increments	Factory Setting	Section
F010	Starting and Stopping Modes	Ramp Type Selection: VR = Voltage Ramp CR = Current PID Ramp 1 = Ramp 1, 2 = Ramp 2	Setting 1 = VR1 + VR2 Setting 2 = CR1 + CR2 Setting 3 = VR1 + CR2 Setting 4 = CR1 + VR2	1	1 VR1+VR2	5.6.2 and Append. 1
F011		Initial Torque (VR) of Ramp 1	0-100% Line Voltage	1%	60%	
F012		Initial Torque (CR) of Ramp 1	0-600% Motor Current	1%	200%	
F013		Accel Ramp Time of Ramp 1	1-120 seconds	1 second	10 seconds	
F014		Max Current Limit of Ramp 1	200 - 600% Motor Current	1%	350%	
F015		Initial Torque (VR) of Ramp 2	0-100% Line Voltage	1%	60%	5.6.2, Append. 1 and 4.2.5.b
F016		Initial Torque (CR) of Ramp 2	0-600% Motor Current	1%	200%	
F017		Accel Ramp Time of Ramp 2	1-120 seconds	1 second	10 seconds	
F018		Max Current Limit of Ramp 2	200 - 600% Motor Current	1%	350%	

Table 5.5.2: Starting Mode Function Group

5.5.3 Jog Mode Functions

Fn #	Group	Function Description	Adjustment / Display Range	Setting Increments	Factory Setting	Section
F019	Jog Modes	Voltage Jog	5 – 100% Line Voltage	1%	50%	5.6.3 and 4.2.5.b
F020		Time of Voltage Jog	1 – 20 Seconds	1 second	10 seconds	
F021		Current Jog	100 – 500% Motor Current	1%	150%	

Table 5.5.3: Jog Mode Function Group

5.5.4 Kick Start Mode Functions

Fn #	Group	Function Description	Adjustment / Display Range	Setting Increments	Factory Setting	Section
F022	Kick Mode	Kick Start Voltage	0 = Disabled, or 10 - 100% Line Voltage	1%	0 Disabled	5.6.4
F023		Kick Start Time	0.1 - 2 Seconds	0.1second	0.8 seconds	

Table 5.5.4: Kick Start Mode Function Group

5.5.5 Decel Mode Functions

Fn #	Group	Function Description	Adjustment / Display Range	Setting Increments	Factory Setting	Section
F024	Pump Flex Decel Mode	Pump Flex Control / Deceleration Ramp	0 = Disabled (coast to stop) 1 = Enabled, except after OL trip 2 = Enabled, continued Decel even if there is an OL trip	1	0 Disabled	5.6.5 and Append. 2
F025		Begin Decel Level (BDL), Immediate Drop Down Torque	0 - 100 % of Output Voltage	1%	60%	
F026		Decel Shut Off Voltage	0 to (BDL minus 1)% Voltage	1%	30%	
F027		Decel Ramp Time	1 – 60 Seconds	1 second	10 seconds	

Table 5.5.5: Pump Flex Decel Mode Function Group

5.5.6 Restart Function

Fn #	Group	Function Description	Adjustment / Display Range	Setting Increments	Factory Setting	Section
F028	Restart	Restart Delay Time (Sequential Start Delay)	0 = Disabled, or 1-999 seconds after a Power Loss (Status can be read in F054)	1 second	0 Disabled	5.6.6
F029		Reserved for Factory Use				

Table 5.5.6: Restart Function Group

5.5.7 Process Timer Features

Fn #	Group	Function Description	Adjustment / Display Range	Setting Increments	Factory Setting	Section
F030	Run Timer and Time Clock Controller Modes	Run Timer Selection	0 = Disabled (No timer operation) 1 = Minimum (Batch) Run Timer 2 = Permissive Run Timer	1	0 Disabled	5.6.7 and Append. 4
F031		Run Timer Time for use in F030 above	1-9999 minutes after a Start Command or Start Event from TCC	1	1	
F032		24hr Time Clock Controller (TCC) Start Event Mode. Chose “One Shot” or 1 to 7 “Start Events” from F033 – F039 Run time for this mode comes from F030 above.	Start Event Cycle (SEC) Settings. 1 = Loop SEC every day 2 = Loop SEC every 2nd day 3 = Loop SEC every 3rd day 4 = Loop SEC every 4th day 5 = Loop SEC every 5th day 6 = Loop SEC every 6th day 7 = Loop SEC one day per week 8 = Single 24hr SEC (until programmed again) 0 = One Shot: Start Event comes from Start command only	1	0 One Shot	
F033		Start Event #1 Start Time	00:00-23:59 (hh:mm) or OFF	1	OFF	
F034		Start Event #2 Start Time	00:00-23:59 (hh:mm) or OFF	1	OFF	
F035		Start Event #3 Start Time	00:00-23:59 (hh:mm) or OFF	1	OFF	
F036		Start Event #4 Start Time	00:00-23:59 (hh:mm) or OFF	1	OFF	
F037		Start Event #5 Start Time	00:00-23:59 (hh:mm) or OFF	1	OFF	
F038		Start Event #6 Start Time	00:00-23:59 (hh:mm) or OFF	1	OFF	
F039		Start Event #7 Start Time	00:00-23:59 (hh:mm) or OFF	1	OFF	

Table 5.5.7: Run Timer and Time Clock Controller Function Group

5.5.8 Current and Ground Fault Protection Features

Fn #	Group	Function Description	Adjustment / Display Range	Setting Increments	Factory Setting	Section
F040	Current and Ground Fault Protection	Current Imbalance Trip	0 = Disabled, or 5 - 30% imbalance	1%	0 Disabled	5.6.8
F041		Current Imbalance Trip Delay	1 - 20 seconds	1 second	2 seconds	
F042		Over Current Trip	0 = Disabled, or 100 - 300% of motor FLA	1%	0 Disabled	
F043		Over Current Trip Delay	1 - 20 seconds	1 second	1 second	
F044		Under Current Trip	0 = Disabled, or 10 - 90% of motor FLA	1%	0 Disabled	
F045		Under Current Trip Delay	1 - 60 seconds	1 second	2 seconds	
F046		Ground Fault Trip	0 = Disabled, or 5 - 90% of CT ratio from Fn 74	1%	0 Disabled	
F047		Ground Fault Trip Delay	1 - 60 seconds	1 second	2 seconds	

Table 5.5.8: Current and Ground Protection Features Group

5.5.9 Lockouts, Reset and Internal Protection Functions

Fn #	Group	Function Description	Adjustment / Display Range	Setting Increments	Factory Setting	Section
F048	Lockouts, Reset and Internal Protection	Coast Down (Back Spin) Lockout Timer	0 = Disabled, or 1 - 60 minutes	1 minute	0 Disabled	5.6.9
F049		Maximum Starts per Hour	0 = Disabled, or 1 – 10 starts	1	0 Disabled	
F050		Minimum Time Between Starts	0 = Disabled, or 1 - 60 minutes	1 minute	0 Disabled	
F051		Internal Protection Settings	1 – 127 See“ F051 Definition Table”	1	127 Enable all	5.6.9.a
F052		Auto Reset on Selected Faults	Fault Preferences 1 – 12 See Table 5.6.8: ”Auto-Reset Selected Faults”	1	4, Phase Loss only	5.6.9.b
F053		Auto Reset Attempts	0 = Disabled, or 1-10 attempts	1	1	
F054		Restart Delay Time Value Readout (for F028)	0-999 Minutes	1	0	5.6.9.c
F055		Coast Down Timer Value for F048	1-3600 Seconds	1	0	
F056		Starts Per Hour Timer Value for F049	1-3600 Seconds	1	0	
F057		Starts Per Hour For F049	1-10 Starts	1	0	
F058		Time Value Between Starts for F050	1-3600 Seconds	1	0	
F059		Thermal Capacity to Start for F005	0-100 % Thermal Capacity	1	0	

Table 5.5.9: Lockouts, Reset and Internal Protection Group

5.5.10 Output Relay Programming Features

Fn #	Group	Function Description	Adjustment / Display Range	Setting Increments	Factory Setting	Section
F060	Output Relays	Aux Relay 1 setting	Operation # 1 – 26: see ”Aux. Relay Settings Chart”	1	1	5.6.10
F061		Aux Relay 2 setting	Operation # 1 – 26: see ”Aux. Relay Settings Chart”	1	2	
F062		Aux Relay 3 setting	Operation # 1 – 26: see ”Aux. Relay Settings Chart”	1	16	
F063		Aux. Relay Delay Timer (for Operations 23-26)	0 (Disabled), or 1-999 seconds	1 second	0 No Delay	
F064		Reserved for factory use				

Table 5.5.10: Output Relay Function Group

NOTE:
Check wiring to each relay before changing programming to ensure there are no unintended consequences.
Relays programmed to some protection features will not operate if function is disabled elsewhere.

5.5.11 Serial Communications

Fn #	Group	Function Description	Adjustment / Display Range	Setting Increments	Factory Setting	Section
F065	Communications	Communications	0 = Disabled 1 = Enabled (11Bit) 2 = Enabled (10Bit)	1	0	5.6.11
F066		Baud Rate	4.8, 9.6 and 19.2 KB	3 rates	9.6 KB	
F067		Modbus Address	1 - 247	1	1	
F068		Remote Starter Control	0 = Disabled 1 = Enabled w/ Start button 2 = Enabled w/o Start button 3 = Enabled via Jog-Remote Input	1	0	
F069		Reserved for factory use				

Table 5.5.11: Serial Communications Function Group

5.5.12 System Settings

Fn #	Group	Function Description	Adjustment / Display Range	Setting Increments	Factory Setting	Section
F070	System Settings	Parameter Lock Customer Password	0 – 999 0 = Disabled Any Other Numbers = Password	1	0 (displays encrypted code)	5.6.12 and Append. 3
F071		System Clear / Reset	0 = Disabled 1 = Clear THR and Lockout Timers 2 = Reset to Factory Default Settings	1	0	5.6.12
F072		Reserved for Factory Use				
F073		Frame Rating	18 - 550	1	By Model (defaults to 48)	5.6.12
F074		CT Value	40-1200	5	By Model (defaults to 40)	
F075		Year	2000 - 2047	1 year	2000	5.6.12.a
F076		Month	1 - 12	1 Month	1	
F077		Day	1 - 31	1 Day	1	
F078		Hour	0 - 23	1 Hour	0	
F079		Minute	0 - 59	1 Minute	0	
F080		Second	0 - 59	1 Second	0	
F081		Revision #	-	-	Factory Setting	
F082 – F084		Reserved for factory use				

Table 5.5.12: System Settings Function Group

5.5.13 Fault History and Run Time

Fn #	Group	Function Description	Adjustment / Display Range	Setting Increments	Factory Setting	Section
F085	Fault History and Run Data	Fault History #1, Latest Fault	0 = No fault history, or Fault # 1 - 27: see Fault code list	1	0	5.6.13
F086		Time Stamp, Fault #1 Based on F078-80	00.00-23.59 (hh.mm) [hh = 00-23; mm = 00-59]	00.01	00.00	
F087		Date Stamp, Fault #1 Based on F076-77	01.01 – 12.31 (MM.DD) [MM = 01-12; DD = 01-31]	00.01	01.01	
F088		Fault History #2, Previous Fault	0 = No fault history, or Fault # 1 - 27: see Fault code list	1	0	
F089		Time Stamp, Fault #2	00.00-23.59 (hh.mm) [hh = 00-23; mm = 00-59]	00.01	00.00	
F090		Date Stamp, Fault #2	01.01 – 12.31 (MM.DD) [MM = 01-12; DD = 01-31]	00.01	01.01	
F091		Fault History #3, Oldest Fault	0 = No fault history, or Fault # 1 - 27: see Fault code list	1	0	
F092		Time Stamp, Fault #3	00.00-23.59 (hh.mm) [hh = 00-23; mm = 00-59]	00.01	00.00	
F093		Date Stamp, Fault #3	01.01 – 12.31 (MM.DD) [MM = 01-12; DD = 01-31]	00.01	01.01	
F094		Run Time, Hours	000.0 – 999.9 hours	0.1 hours	0	5.6.13.a
F095		Run Time, 1000 Hour Overflow	0000 – 9999 thousand hours	1 k-hour	0	
F096		Run Cycle Counter	0000 – 9999 times	1 times	0	
F097		Run Cycle Counter 10K overflow	0000 – 9999 10 thousand times	10k times	0	

Table 5.5.13: Fault History and Run Data Group

5.6 Function Descriptions

Your ***TE Series*** starter is set at the factory with typical default settings that perform well in most applications. Following are detailed descriptions of each Function and the factory default settings.

5.6.1 Motor and Overload Function Descriptions

MOTOR FLA (F001) must be programmed for unit to operate!

F001= Motor FLA
Factory Setting = 0
Range = 50 - 100% of Unit Max. Current.
Set the value of this function to the motor nameplate Full Load Amps (FLA). Adjustments for service factor are not necessary when programming this function. (See note below). If the motor nameplate FLA is not available, use typical values as shown in NEC, NEMA standard MG-1 or other reputable third party source (motor manufacturer, etc.).

- **NOTE:**
  To prevent adjusting the settings beyond the starter Max Amp rating, the range of adjustment for the Motor Nameplate FLA will vary in accordance with the Service Factor as programmed into F002. At the default setting of 1.0SF, the full range of adjustment from 50 - 100% of the Max Amp rating is available. As the Service Factor is increased, the FLA range will drop by an equal ratio. For example if F002 = 1.15 (a 1.15 Service Factor), the maximum FLA programmable into F001 will be limited to 85% of the starter Max. Amp rating (100% - 15%).

F002 = Service Factor
Factory Setting = 1.0 S.F.
Range = 1.00 - 1.30
Set value according to the Service Factor (SF) data provided on the motor's nameplate. This value affects several protection features so it must be accurate. Setting the SF too high may result in motor damage in an overload condition. Setting SF too low may cause nuisance trips however; a 1.0 SF setting is safest if SF is unknown.

- **NOTE**:
  The combination of F002 and F001 (FLA x SF) cannot exceed the Unit Max Amp rating. If when programming F002 you are not allowed to raise the setting, the combined total has been exceeded.

F003 = Overload Class During Start
Factory Setting = 10 (Class 10)
Range = NEMA / UL Class 5 - 20
Set value to the motor protection overload class required for the application. It is recommended that you try the factory setting first. (If possible, keep values for F003 and F004 the same.) Increase F003 above F004 only if nuisance tripping occurs during start. See Section 3.2 for details on trip curves.

F004 = Overload Class During Run
Factory Setting = 10 (Class 10)
Range = 5 - 30 NEMA / UL Class
Set value according to the instructions provided by your motor / equipment manufacturer. This trip curve will not be enabled until the motor has reached full speed.

F005 = Overload Reset
Factory Setting = 0 (Manual)
Range = 0 – 2
Set value to determine starter behavior after an overload condition has cleared.

When set to 0 = Manual, the operator must press the **[RESET]** key before restarting the motor. Once the motor windings have cooled sufficiently AND the **[RESET]** key is pressed, the unit will accept a restart command.

When set to 1 = Automatic mode, and once sufficient time has elapsed allowing motor windings to cool, the motor will be restarted upon a start command. If 2-wire control is used, the unit will restart immediately.

When set to 2 = Disabled Overload, the ***TE Series*** will *not* trip on Motor Thermal Overload. This is provided for applications where either an external Overload Relay or Motor Protection Relay is used, or where multiple motors are connected and each one requires having an individual Overload Relay. See Appendix 5 for more details.

⚠WARNING

Setting F005 = 1 (Automatic) may present significant operational risk.

When F005 = 2 (Disabled Overload), a separate external thermal overload protection device must be in the circuit.

- **NOTE:**
  Because of the risk of fire or equipment damage, cycling control power will NOT reset an Overload Trip. If F005 = 2 (Automatic Reset), cycling control power will allow reset ONLY IF the Thermal Register has determined that the motor has regained sufficient thermal capacity to allow it to restart successfully.

F006 - F009 = Reserved

5.6.2 Starting Mode

The ***TE Series*** is capable of several different starting modes, but is set from the factory for the most common applications. A second ramp profile is available for use should you need it. Unless wired to do so, the ***TE Series*** defaults to Ramp 1. This section describes functions for Ramp 1, with references to function numbers that do the same thing for Ramp 2 (if required). **Refer to Appendix 2 for a detailed description** of the differences in Ramp Profiles and their uses. All current percentages are based on the Motor FLA as programmed in F001.

F010 = Ramp Profile Selection
Factory Setting = 1
Range = 1 – 4
This Function selects the type of Ramp Profile desired. Ramp profiles can be either Voltage Ramp or Current Ramp. See Appendix 2 for details. Each Ramp Profile consists of 3 settings: Initial Torque, Ramp Time and Maximum Current Limit. Because there are two ramps available, there are 4 settings to cover the combinations of profiles possible. If you are not using the 2nd ramp, the ***TE Series*** will ignore all settings in reference to Ramp 2.

	Ramp 1 (Dual Ramp Input Open)	Ramp 2 (Dual Ramp Input Closed)
F010 Setting	Ramp Profile	Ramp Profile
1	Voltage	Voltage
2	Current	Current
3	Voltage	Current
4	Current	Voltage

Table 5.6.2: Ramp Type selection Settings

Select Voltage Ramp by setting F010 = 1 (factory default)
When Voltage Ramp is selected,
Set Initial Torque (Voltage) with F011 (see below)
Set Ramp Time with F013 (see below)
Set Maximum Current Limit with F014 (see below)

Or;

Select Current Ramp by setting F010 = 2
When Current Ramp is selected,
Set Initial Torque (Current) with F012 (see below)
Set Ramp Time with F013 (see below)
Set Maximum Current Limit with F014 (see below)

- **NOTE:**
  When either Ramp is set to “Voltage Ramp”, the corresponding “Initial Torque (Current)” setting is ignored. Conversely, when set to “Current Ramp”, the “Initial Torque (Voltage)” is ignored.

F011 = Initial Voltage of Ramp 1
Factory Setting = 60%
Range = 0 - 100%
Sets the initial voltage of ramp 1 when F010 = 1 or 3. The initial torque level should be set to provide just enough torque to make the motor shaft begin to rotate while preventing torque shock damage to mechanical components.

F012 = Initial Current of Ramp 1
Factory Setting = 200%
Range = 0 - 600%
Sets the initial current of ramp 1 (when F010 = 2 or 4). The initial torque level should be set to provide just enough torque to make the motor shaft begin to rotate while preventing torque shock damage to mechanical components.

F013 = Accel Ramp Time of Ramp 1
Factory Setting = 10 seconds
Range = 1 - 120 seconds
Sets the time between the initial torque (set with F011 or F012) and either the Max Current Limit (set with F014) or full output voltage. Set time to enable soft starts without stalls. Also, consider your motor's application. For example, centrifugal pumps may require a shorter ramp time.

- **NOTE:**
  Ramp time is affected by the following conditions:

1. Current limit will extend the ramp time if the motor does not reach full speed while in current limit mode.
2. Anti-oscillation circuit may shorten the ramp time if the motor reaches full speed before end of ramp.

F014 = Max Current Limit of Ramp 1
Factory Setting = 350%
Range = 200 - 600%
Sets the maximum motor current that the ***TE Series*** starter will allow during Ramp 1. This limit applies to both voltage and current-type ramping. Current will be limited to this setting until either the motor reaches full speed or the over load protection feature trips (F003).

- **5.6.2.a Ramp 2 (user-optional ramp)**

  This ramp is selected by closing the input for Ramp 2, TB1 – terminals 5 & 6 (see section 4.2.5). If this input is left open, the ***TE Series*** will respond only to Ramp 1 settings as listed above. Since ramp 2 is always used as an alternate to the default Ramp 1, different combinations of ramp profiles can be selected in F010. Refer to Appendix 1 for additional information on ramp profiles.

F015 = Initial Torque (Voltage) of Ramp 2
Factory Setting = 60%
Range = 0 - 100%
Sets the initial voltage of Ramp 2 when F010 = 1 or 4. The initial torque level should be set to provide just enough torque to make the motor shaft begin to rotate while preventing torque shock damage to mechanical components.

F016 = Initial Torque (Current) of Ramp 2
Factory Setting = 200%
Range = 0 - 600%
Sets the initial current of Ramp 2 when F010 = 2 or 3. The initial torque level should be set to provide just enough torque to make the motor shaft begin to rotate while preventing torque shock damage to mechanical components.

F017 = Accel Ramp Time of Ramp 2
Factory Setting = 10 seconds
Range = 1 - 120 seconds
Sets the time between the initial torque (set with F015 or F016) and either the Max Current Limit (set with F018) or full output voltage. Set time to enable soft starts without stalls. Also consider your motor's application. For example, centrifugal pumps may require a shorter time. See NOTE under F013 for more details.

F018 = Max Current Limit of Ramp 2
Factory Setting = 350%
Range = 200 - 600%
Sets the maximum motor current that the ***TE Series*** starter will allow during ramp 2. (This limit applies to both voltage and current-type ramping.) Current will be limited to this setting until either the motor reaches full speed or the over load protection feature trips (F003).

- **NOTE**:
  Ramp 2 is often useful as a "bump start" or as a temporary Across-the-Line start mode. Consult Appendix 1 for details.

5.6.3 Jog Mode

The Jog Function is another user optional feature and is controlled by closing the input on TB1 Terminals 6 and 7. If this input is left open, the ***TE Series*** will ignore all Jog settings. Engaging the Jog feature along with the Start / Run Command provides an output from the SCRs, but will not continue ramping to full acceleration. This feature can Jog the motor at either a preset Voltage (F019 – F021) or a preset Current (F021) depending upon the settings of the Ramp Type from F010, and can be initiated along with Ramp 1 or Ramp 2 (see Dual Ramp Select, Section 4.2.5 and 5.6.2.a). It is also sometimes useful to use Jog in combination with Ramp 2, see section 4.2.5.c.

NOTE: Jog functions may become disabled by Comm port function F068 setting 3. See section 5.6.11 for details.

	Ramp 1 (Dual Ramp Input Open)			Ramp 2 (Dual Ramp Input Closed)		
Setting from F010	**Ramp & Jog Type**	**Initial Torque from…**	**Jog Torque from…**	**Ramp & Jog Type**	**Initial Torque from…**	**Jog Torque from…**
1	Voltage	F011	F019	Voltage	F015	F019
2	Current	F012	F021	Current	F016	F021
3	Voltage	F011	F019	Current	F016	F021
4	Current	F012	F021	Voltage	F015	F019

Table 5.6.3: Jog Settings

⚠CAUTION
Although the Thermal Register tracks all motor current use, continuous usage of the Jog feature risks thermal motor damage or nuisance tripping.

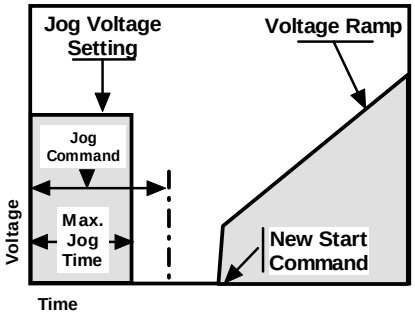


Figure 5.6.3.1: Voltage Jog and Jog Time

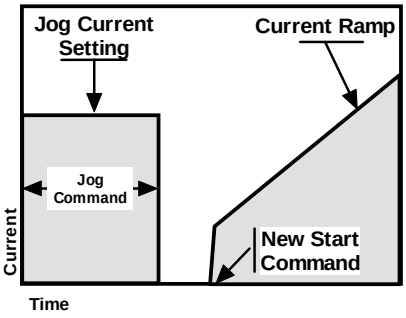


Figure 5.6.3.2: Current Jog

F019 = Voltage Jog
Factory Setting = 50%
Range = 5 - 100%
Sets the voltage level of the Jog feature and is typically used to check rotation, alignment, or to slowly move a load into position. Jogging at a set voltage has no current control so the duration of the applied voltage must be limited to prevent excessive motor heating.

F020 = Time of Voltage Jog
Factory Setting = 10 seconds
Range = 1 - 20 seconds
Set to minimize motor heating during a voltage jog. This setting is the **maximum** allowable time for jogging the motor using voltage only.

F021 = Current Jog
Factory Setting = 150%
Range = 100 - 500%
Sets output of a current Jog. The current jog feature is typically

used to check rotation, alignment, or slowly move a load into position. This is not time-limited but should be used cautiously.

5.6.4 Kick Start Mode

Kick Start applies a pulse of voltage to the motor producing a momentary "kick" of high torque to break the motor load free from high friction or frozen components. This pulse is limited to 2 seconds.

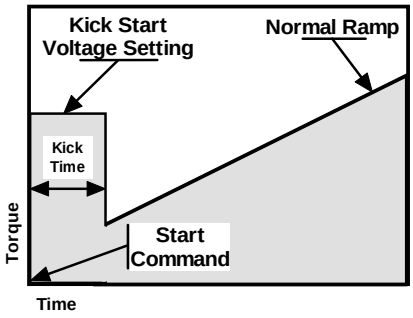


Figure 5.6.4:
Kick Start

F022 = Kick Start Voltage
Factory Setting = 0 (Disabled)
Range = 10 - 100%
When F022 = anything but 0, a voltage "pulse" is applied before the initial torque setting of F011 (or F012 if Current Ramp). This sets the voltage level and the duration of the pulse is set by F023. This setting should be higher than F011 (except for Dwell Starting, see below) and high enough to provide a benefit in the worst starting condition.

F023 = Kick Time
Factory Setting = 0.8 seconds
Range = 0.1 - 2 seconds
Sets the duration of time the Kick Start voltage is applied.

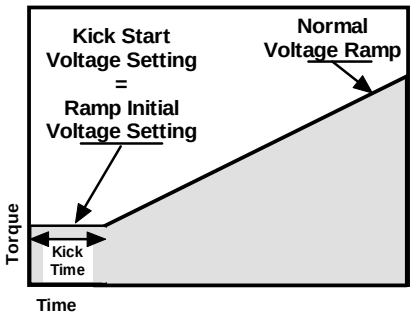


Figure 5.6.4.a:
Dwell Start Using Kick Start

- **5.6.4.a "Dwell" operation using Kick Start**
  In some applications such as chain drive machinery, the Kick Start feature can be used to slowly take up slack in the drive chain before applying full torque. This is referred to as "Dwell Starting" because the torque output stays low for a short time. To take advantage of this feature, simply set the Kick Start to the same level as the Initial Torque setting. This will only work in Voltage Ramp mode.

- **NOTE:**
  Do not use the Kick Start feature unless you determine that you need it. Using this feature may eliminate many of the mechanical and electrical benefits of using a Soft Starter.

5.6.5 Pump-Flex® Decel Mode (F025 through F028)

Pump-Flex® deceleration is a feature of the ***TE Series*** Soft Starter that slowly decreases the applied voltage to the motor when a stop command is given, resulting in a gentle decrease in motor torque. Deceleration provides a way to extend the stopping time so that abrupt stopping does not occur. Deceleration is useful with centrifugal pumps, material handlers, and conveyors where abrupt stopping could be damaging to the equipment and/or load.

SEE APPENDIX 2 AT THE END OF THIS MANUAL for typical Pump-Flex® Decel feature applications and more detailed descriptions of the following functions.

F024 = Deceleration Ramp
Factory Setting = 0 (Disabled)
Range = 0 – 2

When F024 = 0, the deceleration feature is **disabled**.

When F024 = 1, the deceleration feature is **enabled** AND the overload protection feature (from F003 - F005) remains active (power off on OL trip).

When F024 = 2, the deceleration feature is **enabled** and deceleration will **continue even when an overload condition trips**.

⚠WARNING

Setting F025 = 2 presents significant risk of over-heating the motor beyond its design limits which could result in motor damage and fire hazard. Do this only in circumstances where the potential for mechanical damage outweighs the risk of motor damage.

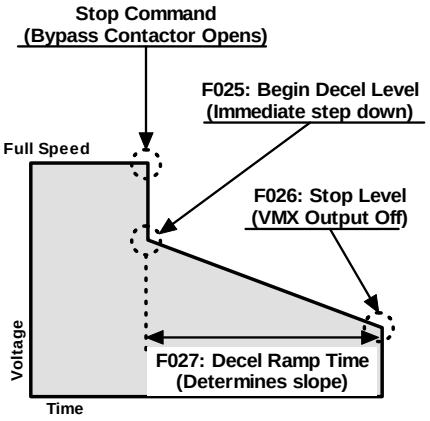


Figure 5.6.5:
Pump-Flex Decel Ramp Settings

F025 = Begin Decel Level (BDL)
Factory Setting = 60%
Range = 0 - 100% of line voltage
Use to drop voltage to a level where there is a noticeable effect on motor torque during initial Decel mode.

F026 = Decel Shut Off Voltage
Factory Setting = 30%
Range = 0 to (BDL -1)%
Sets the level where the starter is turned off, corresponding to where motor torque during Decel is no longer effective. Always set this function lower than the setting of F026

F027 = Decel Ramp Time
Factory Setting = 10 seconds
Range = 1 - 60 seconds
Sets the maximum time for the deceleration ramp to go from the Begin Decel Level setting (F026) to the Decel Shut Off Voltage (F027).

- **NOTE:**
When using the Decel function, count these cycles as additional "starts" when determining maximum starts-per-hour of the motor.

⚠CAUTION
Decel is <u>THE OPPOSITE</u> of braking. Enabling the Decel feature will make the motor take <u>LONGER</u> to stop than if it were simply turned off.

5.6.6 Restart Delay

The ***TE Series*** can be programmed to delay restarting upon restoration of line power after an outage. This allows multiple units to be programmed to restart at staggered times in an effort to avoid causing additional problems with the power supply system. Another term for this is "**Sequential Start Delay**".

F028 = Restart Delay Time
Factory Setting = 0 (Disabled)
Range = 0 = Disabled (no delay), or 1 - 999 seconds
Sets a delay time before the starter can be restarted after a complete loss of power. Use this if multiple motors are connected to a supply system that may have trouble providing adequate power to restart them all at the same time. By using different Restart Delay Times on each unit, a sequential restart can be achieved.

- **NOTE:**
  This is similar to the Coast Down Lockout Timer in F048, however it only activates on Power Loss.

F029 = Reserved

5.6.7 Process Timer Control Mode (F030 through F039):

The following special functions allow the ***TE Series*** starter to operate automatically from a Process Control Timer using an internal Real Time Clock.

Only brief descriptions of the functions are provided here.
REFER TO APPENDIX 4 **at the end of this manual for detailed operations and instructions.**

- **NOTE:**
  These functions may interact with the Coast Down Lockout (F048), Starts-per-Hour Lockout (F049), Minimum Time Between Starts (F050), Auto-Reset (F052 and 53) and Restart Delay Time (F028) functions if enabled. Be sure to review and understand settings for these functions before using the Process Timer.

F030 = Process Control Timer Selection
Factory Setting = 0 (Disabled)
Range = 0, 1, 2
This function enables a Process Control Timer, which may be used alone or in conjunction with the Time Clock Controller feature (F032-F039). This timer offers two operating modes, selected by entering 1 or 2 into the function parameter:

Setting 1 = Minimum (Batch) Run Timer: After a Start Command, the starter runs until the batch timer expires. If stopped and restarted it will complete that batch time sequence.

Setting 2 = Permissive Run Timer. After a Start Event from the TCC, the starter can be started and stopped as necessary, until the timer expires.

F031 = Process Timer Value
Factory Setting = 1
Range = 1 – 9999 minutes
This function loads a value into the Process Timer above. When initialized, the value counts down towards 0.

- **NOTE:**
  The above Process Control Timer in F030 – F031 works in conjunction with the Time Clock Controller in F032 – F039. When the TCC is set to One-Shot (F032 = 0), this timer will activate whenever a Start Command is given. When F032 = any other setting, this timer activates according to that schedule.

F032 = Real Time Clock Controller
Factory Setting = 0 (One Shot)
Range = 0 - 8 settings
This function is used to select the operating mode of the 24hr / 7 Day Time Clock Controller (TCC). F032 sets the number of days in which the TCC will repeat the Start Event Cycle of up to seven discrete Start Events selected in F033 through F039. After each Start Event, the ***TE Series*** will run per the time value set in F030 above. If F030 = 0, the TCC settings are ignored. See Appendix 4 for additional details.
1 = 1 day per week,
2 = 2 days per week
…
7 = 7 days per week
8 = A single 24HR event, non-repeating
0 = One-Shot. When set to 0, the ***TE Series*** responds only to each Start input command. Use this setting to allow the Process Timer to operate without the TCC **(see Appendix 4 if F030=2).**

F033 = Event #1 Start Time
Factory Setting = OFF
Range = 00:00 through 23:59, or OFF
This function is used to select the start time for Event #1 in the RTCC above. Once started by this event, the TE will run the motor according to the selections entered into F030 and F031.

F034 = Event #2 Start Time
Factory Setting = OFF
Range = 00:00 through 23:59, or OFF
This function is used to select the start time for Event #2 in the TCC above.

F035 = Event #3 Start Time
Factory Setting = OFF
Range = 00:00 through 23:59, or OFF
This function is used to select the start time for Event #3 in the TCC above.

F036 = Event #4 Start Time
Factory Setting = OFF
Range = 00:00 through 23:59, or OFF
This function is used to select the start time for Event #4 in the TCC above.

F037 = Event #5Start Time
Factory Setting = OFF
Range = 00:00 through 23:59, or OFF
This function is used to select the start time for Event #5 in the TCC above.

F038 = Event #6 Start Time
Factory Setting = OFF
Range = 00:00 through 23:59, or OFF
This function is used to select the start time for Event #6 in the TCC above.

F039 = Event #7 Start Time
Factory Setting = OFF
Range = 00:00 through 23:59, or OFF
This function is used to select the start time for Event #7 in the TCC above.

5.6.8 Current and Ground Fault Protection Features

F040 – F050 set extended protection features that may be used in the ***TE Series*** starter. Percentages shown are all based automatically upon the Motor FLA setting from F001 (except Ground Fault, F046). No additional calculations are necessary.

- **NOTE:**
  All of these features are disabled at the factory and must be enabled via user programming as follows:

F040 = Current Imbalance Trip
Factory Setting = 0 (Disabled)
Range = 5 - 30% or 0 (Disabled)
Use to set the trip level for when current imbalance between any two phases exceeds this amount for the time specified with F041.

F041 = Current Imbalance Trip Delay
Factory Setting = 2 seconds
Range = 1 - 20 seconds
Provides a time delay to prevent nuisance trips from short-duration transients. Using default settings, if the difference in output current between two phases exceeds 10% of FLA for more than 2 seconds, the starter will trip.

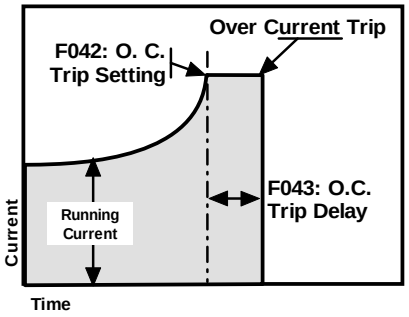


Figure 5.6.8.a: Over Current Trip

F042 = Over Current Trip / Shear Pin Trip
Factory Setting = 0 (Disabled)
Range = 100 - 300%, 0 (Disabled)
When a value other than 0 is entered for F042, the starter will trip when the output current of any phase exceeds the amount set and the time specified in F043. This is also referred to as a "Shear Pin Trip" and can be used to protect mechanical components from breaking due to jammed loads.

F043 = Over Current Trip Delay
Factory Setting = 1 second
Range = 1 - 20 seconds
Provides a time delay to prevent nuisance trips from short-duration transients. For example using default settings, if the output current of any phase exceeds F042 for more than 1 second, the starter will trip.

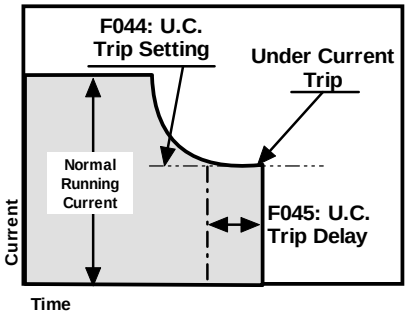


Figure 5.6.8.b: Under Current Trip

F044 = Under Current Trip
Factory Setting = 0 (Disabled)
Range = 10 - 90%, or 0 (Disabled)
When a value other than 0 is entered for F044, the starter will trip when the output current of any phase drops below the amount set, and the time specified in F045. This fault condition is often referred to as a "Load Loss Trip" and can be used to detect a broken shaft, V belt or other mechanical drive system component. In pumping applications, this can be used as a "Loss of Prime" trip.

F045 = Under Current Trip Delay
Factory Setting = 2 seconds
Range = 1 - 60 seconds
Provides a time delay to prevent nuisance trips from short-duration transients. Using default setting, if the output current of any phase drops below F044 for more than 2 seconds, the starter will trip.

- **5.6.8.a Ground Fault**
  F046 – F047 provides Ground Fault protection for equipment only (a.k.a. Arcing Ground Fault) using the Residual Current method. Trip settings are based on the CT ratio as shown in F074 (see below). A delay time is available in F047 to help prevent nuisance trips. Ground current can always be viewed in the Status Display, shown with a “G” prefix (see section 5.3.1).

⚠WARNING

THIS IS NOT INTENDED TO BE USED AS "PERSONNEL PROTECTION" GROUND FAULT! This feature is only intended to provide a level of equipment protection against damaging ground currents. Ground faults are potentially dangerous conditions and must be corrected immediately for safety of operating personnel.

F046 = Ground Fault Trip
Factory Setting = 0 (Disabled)
Range = 5 - 90% of CT value, or 0 (Disabled)
When a value other than 0 is entered for F046, the starter will trip if current to ground exceeds this percentage of the unit CT value. The CT value is shown in F074 (see section 5.6.12). This value is different from the Unit Rating or FLA setting. To calculate actual ground current, multiply the CT value of F074 by the setting of F046.
Example:
210A starter, desired Ground Fault Trip level is 20A:
On this unit, the CT value reading from F074 will be 250 (250:5)
20 / 250 = 0.08 (8%)
Set F046 to 8

F047 = Ground Fault Trip Delay
Factory Setting = 2 seconds
Range = 1 - 60 seconds
Provides a time delay to prevent nuisance trips from short-duration transients. Using default setting, if the Ground Fault current exceeds the level set in F046 for more than 2 seconds, the starter will trip.

⚠CAUTION

This method of Ground Fault sensing may not provide adequate equipment protection in resistance-grounded systems. We recommend providing external GF protection using a core balanced Zero Sequence CT for those types of applications. Consult factory for additional assistance.

5.6.9 Lockouts, Reset and Internal Protection Features

F048 – F050 provide lockout protection for motors and equipment that may have potentially damaging consequences from premature restart or with limited duty cycles. Time and count values for these lockouts can be viewed in F055 – F058. Time values are based on the Real Time Clock and DONOT reset when power is lost or disconnected. Emergency clearing of lockouts can be accomplished in F071.

- **NOTE:**
  When F048 through F050 are used with 3 wire control systems, a Start command will not seal in during lockout time. When time has expired, a new Start command will be necessary.

⚠WARNING

When F048 through F050 are used with <u>2-wire</u> control, the starter may re-start automatically when time has expired. Adequate warnings similar to those in Section 3.1.3.b should be observed.

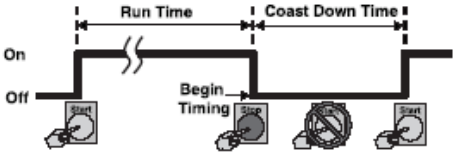


Figure 5.6.9:
Coast Down Lockout Timer

F048 = Coast Down Lockout Timer (Back Spin Timer)
Factory Setting = 0 (Disabled)
Range = 1 - 60 minutes, or 0 (Disabled)
When F048 = 1 through 60, this sets the number of minutes that the starter must be off before a restart can be attempted. This function is useful in applications such as pump motor backspin protection (where you need to prevent the pump motor from restarting if it is spinning backwards), 2 speed operations where speed changes require a minimum disconnect (spin-down timer), or reversing applications to prevent plugging (anti-plugging timer).

F049 = Maximum Starts per Hour Lockout
Factory Setting = 0 (Disabled)
Range = 1 – 10 or 0 (Disabled)
If F049=1 through 10, this feature will count the number of start commands within a 1 hour period. If the setting (maximum starts per hour) is exceeded, starting is prohibited until sufficient time has expired. This timer initiates upon the first start in an hour. It resets after 1 hour from that start and waits until another subsequent start to initiate again. (Often used in conjunction with F050).

- **NOTE:**
- Consult the motor manufacturer for a “Starts-per-Hour” or “Starting Duty Cycle” rating. Larger motors tend to have lower starts-per-hour ratings.
- When using the Decel function (F025) or an electronic braking option, count these cycles as additional “starts” when determining maximum starts-per-hour.

F050 = Minimum Time Between Starts Lockout
Factory Setting = 0 (Disabled)
Range = 1 - 60 minutes, or 0 (Disabled)
When F050 is set to 1 through 60, the motor cannot be restarted within the time specified after the first start. Time between starts is calculated from the time of the first start command to the next regardless of run time or off time.

Example:
If F050 = 15, motor will not be allowed to re-start within 15 minutes of first start.

This function is useful as a "Short-Cycle Timer" in preventing excessive wear on motors where automatic demand control may occasionally cycle on and off too quickly, such as compressors or sump pumps

- **5.6.9.a Internal Protection Features**
  The ***TE Series*** starter contains additional protection features that are built-into the hardware and factory preset. **Function F051** is provided to alter these settings via numerical preset programming. For maximum protection, all of these features are turned On as a factory default and should be left that way unless changes are necessary for service purposes, testing or to accommodate non-standard applications. Factory default settings are as follows:
- **Phase Rotation:** Protection is ON,
  expected rotation sequence is set for A-B-C
- **Phase Current Loss (Running):** Protection is ON, trips at <20% of unit Max amps after 3 seconds of acceleration and at full speed.
- **Shorted SCR:** Protection is ON, unit will lock out if one SCR is shorted (no voltage drop across the SCR)
- **Shunt Trip:** Protection is ON; unit trips if current flows in any phase while in OFF mode.
- **PTC Trip**: Protection is ON; unit will trip if PTC Input resistance exceeds set value (or open).
- **Line Phase Loss (Stopped)**: Protection is ON; unit will trip if any line voltage is not present while the unit is not accelerating or stopped.

F051 = Internal Protection Features
Factory Setting = 127 (all enabled)
Range = 1 – 127: Numeric value representing bit locations
F051 represents the numeric value of a byte (8 bits) of memory which enables or disables these features. Each bit within that byte acts like a "dip switch" to alter the associated feature, but instead of having to open the starter case, changes can be done via the keypad. Each function has a fixed numeric decimal value associated with it. Adding or subtracting decimal values to this function changes the binary (On-Off) status of each bit and is simply done by entering the new value into F051. The Factory Default value is **F051 = 0127**, which has all features On. Numeric values for each feature are as follows:

Phase Rotation Protection:
The ***TE Series*** is set up to monitor an expected Phase Rotation and trip if it changes. Control of this is divided into two categories: On-Off and Expected Sequence. The default setting is On, with and Expected Sequence of A-B-C rotation.

The ability to turn this feature ON or OFF is useful in applications where the ***TE Series*** starter is going to be used downstream from an existing reversing contactor / starter, or to avoid conflicts with other protection devices.

- **Rotation Trip On-Off Control Numeric value = 1.**
  If this feature is On (default setting) and you want to turn it Off, Subtract 1 from F051
  If this feature is Off and you want to turn it On, add 1 to F051
  When set to On, a trip will occur when the Expected Sequence (see below) is wrong.

On large motors where large multiple conductors are used, it may be easier to change the Expected Sequence in the ***TE Series*** starter rather than swap the conductors.

- **Expected Phase Rotation Sequence Numeric Value = 2**
  If A-B-C rotation is the expected sequence (default setting) and you want it to be A-C-B, subtract 2 from F051
  If A-C-B rotation is the expected sequence and you want it to be A-B-C, add 2 to F051
  If Rotation Trip is set to Off (see above), this setting is ignored.

Phase Current Loss (Running) Protection:
This feature will cause a Trip if current in any phase (or all 3) is less than 20% of the unit maximum amp rating after 3 seconds from a Start Command (note that this is based on the Max Amp rating and not the programmed FLA). Turn it to OFF if the motor no-load current is exceptionally low such as in high inertia machines, or **if you are testing a large starter with a small motor**.

- **Phase Loss (Running) Protection Numeric Value = 4**
  If this feature is On (default setting) and you want to turn it Off, Subtract 4 from F051
  If this feature is Off and you want to turn it On, add 4 to F051

Shorted SCR Lockout protection:
This feature will cause a Lockout if at least one SCR is shorted, based on the expected voltage drop across the SCR assembly when the unit is OFF (a shorted SCR cannot be detected while the unit is running or in Bypass mode). If someone who understands the ramifications of having a shorted SCR issue requires an emergency restart, this feature can be turned to OFF. This is not the same as a Shunt Trip circuit (see below). This is a lockout of the NEXT start command.

- **Shorted SCR Lockout Numeric Value = 8**
  If this feature is On (default setting) and you want to turn it Off, Subtract 8 from F051
  If this feature is Off and you want to turn it On, add 8 to F051

Shunt Trip:
Shunt Trip is a feature that will cause an immediate Trip if the ***TE Series*** detects current flowing through any phase (or all) when it is supposed to be off. The trip function is typically associated with Aux. Relay setting 7 (see F060-63), wired to a Shunt Trip coil in an upstream circuit breaker or an in-line contactor. This is so that power flow to the motor windings can be interrupted to prevent damage. The usual cause is multiple shorted SCRs or a welded Bypass Contactor. The only time this should be turned off is for troubleshooting by Service personnel.

- **Shunt Trip <u>Numeric Value = 16</u>**
  If this feature is On (default setting) and you want to turn it Off, Subtract 16 from F051
  If this feature is Off and you want to turn it On, add 16 to F051

PTC Trip:
This feature controls the inclusion of the PTC Input (see Section 4.2.7). When ON (default setting), a jumper wire or other circuit must be installed on the PTC input if a PTC resistor is not included in the motor. Turn this feature to OFF for troubleshooting or if you do not want to worry about the jumper wire.

- **PTC Trip <u>Numeric Value = 32</u>**
  If this feature is On (default setting) and you want to turn it Off, Subtract 32 from F051
  If this feature is Off and you want to turn it On, add 32 to F051

Line Phase Loss (Stopped) Trip:
This feature will prevent the ***TE Series*** starter from attempting to start if voltage in one (or more) of the incoming lines is not present. This can be used to detect a blown fuse or power supply loss (as long as control power is still available). It differs from the Phase Loss (Running) Trip above in that it is based upon line voltage so does not require that a Start Command be given. This trip function resets itself after determining that all 3 phases have voltage applied. The voltage level at which this feature activates is fixed at approximately 100VAC, but is not adjustable and should not be used as Under Voltage protection.

- **Line Phase Loss (Stopped) Trip <u>Numeric Value = 64</u>**
  If this feature is On (default setting) and you want to turn it Off, Subtract 64 from F051
  If this feature is Off and you want to turn it On, add 64 to F051

- **NOTE:**
  1) When using an <u>In-Line Isolation Contactor</u>, it may be necessary to defeat this protection (by subtracting a numeric value of 64 from F051) in order to avoid nuisance tripping whenever the In-Line Contactor opens.

  2) This protection will automatically reset itself when line voltage is present on all 3 phases. When using 3-wire control the ***TE Series*** will not attempt restarting unless the Start Command is reinitiated.

- **⚠CAUTION**
  When using 2-wire control, the starter will restart when this feature resets itself after all 3 phases are present.

5.6.9.a (continued) Function 51: Internal Protection Features

Bit #	Fault Display Code	Protection Function	Description	Default Bit Setting	Decimal Value
0	rtd *	Phase Rotation Trip	Phase Rotation protection. Phase rotation must match selection in Bit #2 below. Setting to Off (0) will make the TE insensitive for use behind a reversing contactor	1 (On)	1
1	ABC	Expected Phase Sequence	2 = A-B-C Phase Rotation Sequence Only 0 = A-C-B Phase Rotation Sequence Only	1 (A-B-C Rotation)	2
2	PLa or PLc*	Phase Current Loss	Phase Current Loss, any phase current reading is less than 20% of unit max amp rating after 3 seconds from Start command.	1 (On)	4
3	SS*	Shorted SCR	At least one SCR has shorted; there is no voltage drop across the SCR phase assembly.	1 (On)	8
4	ST*	Shunt Trip	Shunt Trip of the main Circuit Breaker or Isolation Contactor (if provided and wired to an Aux. relay in F060-F061)). 2 or more SCRs have shorted in opposing phases so current was flowing to the motor while the TE was in the Off state.	1 (On)	16
5	PTc*	PTC Input Trip	PTC Trip function. This can be disabled so that a jumper is not required across the PTC inputs.	1 (On)	32
6	PLd or n3Ph	Line Phase Loss Trip	Protection against loss of input line voltage. Disable when using an In-Line Isolation Contactor or any other system that normally removes line power from the starter. Resets automatically when line voltage returns.	1 (On)	64
7	---	Reserved	Reserved for factory use	0 (Off)	128
* = Operating Mode designation. See Fault Code List for description.					

Table 5.6.9.a: Function 51 table of Hardware Protection Features

- **NOTE**:
  To restore all settings back to the factory default, enter a value of 127. If you see a numeric value other than the default value of 127, one or more features has already been altered. If you do not know which one or ones are changed, the simplest thing to do is determine what combination of settings you want now, and subtract from 127 then enter that number to accomplish it.

Example: F051 reads a numeric value of 109, meaning that something has been changed, but you don't know what. By subtracting 109 from 127, you have a value of 18 remaining, and since 18 does not represent a single bit, it means that some combination has been used. Subtract the largest represented bit, i.e. bit #4 (value of 16), which leaves a value of 2, representing bit #1. So in this example, the Shunt Trip feature had been turned off, and the Expected Phase Sequence had been changed to A-C-B.

If you do not wish to bother with what the previous settings were, simply decide which features you now want to be turned on and come up with a new numeric value to enter. For instance if you want all features on, but you need phase rotation to be A-C-B (bit #1), then simple subtract a value of 2 from 127, and enter 125 into F051.

- **5.6.9.b Auto-Reset Programming (F052 – F054**)
  The ***TE Series*** can be programmed to automatically attempt to reset after selected faults, provided a Start Command is present (see Section 4.2) and the fault condition has been corrected. The Fault Events to attempt restarting (F052) and number of reset attempts (F053) are programmable as follows. If F053 is set to 0 (default setting), the ***TE Series*** will not attempt to restart automatically.

- **NOTE:**
  When using 3 wire control:
  For safety reasons the ***TE Series*** will not attempt restarting unless the Start Command is reinitiated and maintained during a restart attempt.

F052 = Auto-Reset Selected Faults
Factory Setting = 0 (Disabled)
Range = 1 - 12, or 0 (Disabled)
If F053 = 1 through 12, the ***TE Series*** will attempt to restart after the fault(s) coded in the following table. Only one selection can be entered.

F053 Setting	Fault Condition Description	Display Readout Reference
0	Auto Reset Disabled	---
1	Over Temperature Trip	**OT**
2	Over Current (Shear Pin) Trip	**OC**
3	Under Current Trip	**UC**
4	Phase Loss Trip	**PLa or PLc**
5	Current Unbalance Trip	**UB**
6	Ground Fault Trip	**GF**
7	Short Circuit Trip	**SC**
8	Faults 1, 2 or 3 above	**OT, OC or UC**
9	Faults 4, 5 or 6 above	**PL, UB or GF**
10	Any Fault except 7	**No SC**
11	Any Fault except 6 & 7	**No GF and no SC**
12	Any Fault above, 1 - 7	**OT, OC, UC, PL, UB or GF**

1. NOTE 1: UC, OC or UB require operation to resume before the fault can be detected.
2. NOTE 2: Cycling and / or restoration of control power will reset all of the above faults.
3. NOTE 3: Overload Trip reset function is programmed only in F005. See Section 3 for details
4. NOTE 4: Reset attempts that occur when the fault condition is still present will cause a new fault. This will be logged into the fault history (F085 – F093) and may overwrite previous fault records.
5. Line Loss Trip (see F051) will automatically reset and so is not included in this list.

Table 5.6.9.b: Faults Selected for Auto-Restart

F053 = Auto-Restart Attempts
Factory Setting = 0 (Disabled)
Range = 1 - 10 Attempts, or 0 (Disabled)
If F052 = 1 through 10, the ***TE Series*** will attempt to restart if the Start Command is present for this number of times. If set to Zero, the starter will not attempt to reset automatically.

- **5.6.9.c Timer Value Readouts for Protection Features**
  F054 – F059 provide display of timer or register values for information only. The user cannot alter them. Upon power loss and restoration, these values are updated for time elapsed.

F054 = Restart Delay Time Readout
Factory Setting = Not Applicable
Range = 1 - 999 Seconds
Remaining time value readout of F028, the Auto-Restart Delay Timer.

F055 = Coast Down (Backspin) Timer Value
Factory Setting = Not Applicable
Range = 1 - 3600 Seconds
Remaining time value readout of F048, the Coast Down Lockout Timer.

F056 = Starts per Hour Timer Value
Factory Setting = Not Applicable
Range = 1 - 3600 Seconds
Remaining time value readout of F049, the Starts-per-Hour Lockout Timer.

F057 = Starts per Hour Counter Readout
Factory Setting = Not Applicable
Range = 1 - 10 Starts
Incremental counter value readout of F050, the Starts-per-Hour Lockout.

F058 = Time Value Between Starts Readout
Factory Setting = Not Applicable
Range = 1 - 3600 Seconds
Remaining time value readout of F050, the Minimum Time Between Starts Timer.

F059 = Thermal Capacity to Start Readout
Factory Setting = Not Applicable
Range = 0 - 100 % Thermal Capacity
Readout only for user's viewing of the motor Thermal Capacity percentage required to allow a Reset after an Overload Trip. Use this function in conjunction with the Remaining Thermal Capacity (in the Status Screen group) to be able to predict when a restart will be allowed. This value is automatically updated by the ***TE Series*** CPU whenever a successful start sequence has been accomplished. The ***TE Series*** essentially "learns" how much Thermal Capacity is needed in the motor in order to successfully restart, and stores the information at this Function. Upon power loss and restoration, this value is updated for elapsed time.

5.6.10 Output Relays

There are three programmable relays (rated 240VAC, 5A, 1200 VA) in the ***TE Series***. They can be programmed for change of state indication for any one of the 25 conditions identified in the following chart.

F060 = Aux Relay 1: Form C (SPDT)
Factory Setting = 1 (Run / Stop)
Range = 1 - 26 (See list)
Use to program the desired operation for Relay # 1.

F061 = Aux Relay 2: Form C (SPDT)
Factory Setting = 2 (At Speed / Stop)
Range = 1 - 26 (See list)
Use to program the desired operation for Relay # 2.

F062 = Aux Relay 3: Form A (SPST, N.O.)
Factory Setting = 16 (Any Trip, 5 - 15)
Range = 1 - 26 (See list)
Use to program the desired operation for Relay # 3.

F063 = Aux Relay Delay Timer for Settings 23 – 26
Factory Setting = 0 (Disabled)
Range = 1 – 999 seconds, or 0 (Disabled)
Use to program the desired On Delay for any Aux. Relay that has been programmed for Settings 23 through 26 from the chart below.

Setting	Relay Operation Description
1	Run / Stop (Changes on Start Command, resets on Stop)
2	At Speed / Stop
3	At Speed / End of Decel
4	Start / End of Decel
5	Short SCR Trip
6	Phase Loss Trip
7	Shunt Trip
8	OL (Motor Thermal Overload) Trip
9	OT (Starter Thermal Over Temperature) Trip
10	Short Circuit Trip
11	Current Unbalance Trip
12	Over Current (Shear-Pin) Trip
13	Under Current Trip
14	Ground Fault Trip
15	Phase Rotation Trip
16	Any Trip (#5 - #15)
17	Any Trip, (#5-#15) **flashing output***
18	Coast Down Time Lockout
19	Starts Per Hour Lockout
20	Time Between Starts Lockout
21	Any Lockout (#18-#20)
22	Run Timer (F030) Engaged
23	Run / Stop with On-delay from F063
24	At Speed / Stop with On-delay from F063
25	At Speed / End of Decel with On-delay from F063
26	Start / End of Decel with On-delay from F063
***NOTE: Flash rate for Setting #17 is ½ second On and Off**	

Table 5.6.10: Output Relay Programming

F064 = Reserved

5.6.11 Communications

The ***TE Series*** starter is shipped from the factory ready to accept RS-485 Serial Communications using Modbus RTU protocol. Additional detailed instructions on accomplishing communications are available in a **Serial Communication Supplement** to this manual. F065 – F067 are used to set the communications parameters in the starter for use by the adaptor module. F068 determines how the Start / Stop functions work through the comm. port.

F065 = Communications
Factory Setting = 0 (Disabled)
Range = 0 – 2
This enables serial communications with remote monitoring and control systems and sets the format for Modbus RTU protocol. Once Enabled, the local start / stop inputs are altered to avoid inadvertent starting. See F068 for details.
When F065 = 0, communications are disabled.
When F065 = 1, uses the std 11 bit Modbus format w/ parity bit.
When F065 = 2, a non-standard 10-bit format without a parity bit is used to accommodate some systems using this method.

F066 = Baud Rate
Factory Setting = 9.6 KB
Range = 4.8 to 19.2 KB
Set value to either 4.8 KB, 9.6 KB or 19.2 KB and match the setting of the host device.

F067 = Modbus Address
Factory Setting = 1
Range = 1 – 247
The Modbus communications protocol allows each node to have up to 247 connected devices but each must have a unique address. Two devices with the same address will result in a communications error.

F068 = Remote Starter Control
Factory Setting = 0 (disabled)
Range = 0 – 3
Use this to program how the ***TE Series*** starter is to be controlled when using serial communications.
When F068 = 0, the starter can be monitored by the Comm port, but not controlled.
When F068 = 1, the starter will be controlled by the comm port. In addition, the Start / Stop inputs are altered as follows: The hard-wired Start command is put in "**AND"** logic with the Comm port; both Start commands must be on for the TE to start. The Stop function is put in "**OR"** logic; either the Comm. port Stop command **OR** the hard-wired Stop will cause the TE to stop.
When F068 = 2, the TE starter is in full control of the Comm. port only. Local Start / Stop inputs become completely inactive. Use this function only when controlled shutdown is a priority.
When F068 = 3, the TE starter will change the function of the **Jog / Remote Input** to cause a switch between the functions of setting **0** and setting **1** as listed above. When the input is open, the starter will respond to the Comm port as per setting 0 above. When the **Jog / Remote Input** is closed, the starter will respond as per setting 1 above. Use this function if it is necessary to have a return to local start/stop control should the communications system fail or become disconnected.

Special Note when using Serial Comm:
When F068 = 3, the function of the Jog / Remote Input on TB-1 terminals 7 and 8 will change. Closing the Input will cause the Comm. port control to function as per setting 1. Leaving the input open will cause the Comm. port to function as per setting 0.

When F068 = 1, 2 or 3, the Jog function will cease to operate. Since Jogging is a local function, set F068 to 0 when using it.

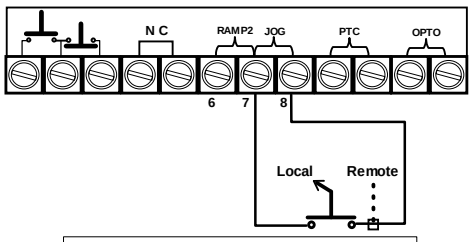


Figure 5.6.11:
Local - Remote Control Connections to TB-1
Only when F068 = 3

F069= Reserved

5.6.12 System Settings

The following functions set operator interface controls and unit programming. Also contained here are the Clock settings used for history functions. Change the Clock settings if accurate time values are important.

F070 = Parameter Lock / User Password
Factory Setting = 0 (disabled)
Range = 0 – 999
Use only when necessary to prevent unauthorized access. Provides users with the ability to prevent unauthorized operators from making changes to the programmed functions. If you do NOT need to take advantage of this feature, do not enter anything into this function. The factory default is disabled, and no Password is necessary to make changes to the program.

See Appendix 3 at the end of this manual for detailed instructions on using and altering the Parameter Lock / User Password feature.

F071 = Emergency Clear / Reset
Factory Setting = 0 (disabled)
Range = 0 – 2
This Function serves two purposes. It can clear the memory values used for lockouts and overload protection, and it can reset all functions to the factory default settings. This is a "One-Shot" feature, so when another value is entered as shown below, this function automatically returns to the default state.

- **When F071 = 0**, the feature is disabled.
- **When F071 = 1**, the values stored in the Thermal Register and all of the Lockout Timers will be cleared. This will allow an **emergency restart** without having to wait for proper cool down time or lockout timers to expire.

⚠WARNING

Clearing the Thermal Register to allow restarting without proper cool-down time after an Overload Trip will risk motor damage and fire. Use only where emergency restart is necessary with knowledge of these potential hazards.

- **When F071 = 2,** the values of all functions will be reset to the factory default settings. Use this feature when settings conflict or have been tampered with. This is also useful when you lose track of experimental settings and wish to start over. It will also be used to clear the Fault History.

- **NOTE**:
  This will not reset F070 = Parameter Lock / User Password. See Appendix 3 for resetting this feature.

F072 = Reserved

F073 = Unit Frame Rating:
Read Only. Reserved for Factory Use

F074 = CT Ratio:
Read Only. Primary value of the ***TE Series*** internal Current Transformers (CTs) for use in determining the GF trip settings (F046). CTs cannot be used for external metering. Alteration is reserved for factory use only.

- **5.6.12.a Real Time Clock Settings**
  Functions F075 through F080 set the system real time clock. The time clock is used in the 24hr Time Clock Controller operation (F032 – F039) and for date/time stamping of the Fault History. The clock automatically adjusts for leap years and is backed up with a Li battery for long life.

- **NOTE:**
  Time clock does not automatically adjust for daylight savings time.

F075= Year
Factory Setting = Year of manufacture
Range = 2000 to 2047

F076 = Month
Factory Setting = Month of manufacture
Range = 1 – 12

F077 = Day
Factory Setting = Day of manufacture
Range = 1 – 31

F078 = Hour
Factory Setting = Actual (EST)
Range = 0 - 23 (12:00 midnight is hour 0)

F079 = Minute
Factory Setting = Actual (EST)
Range = 0 – 59

F080 = Second
Factory Setting = Actual (EST)
Range = 0 – 59

F081 = Firmware revision number for Factory Use

F082 -F084 = Reserved

5.6.13 Fault History and Statistical Data

F085 – F097 contain the Fault History and Statistical data about the Run Mode.

- **5.6.13.a Fault History**
  Fault codes for each of the three latest events are stored with time and date stamps; see Chapter 7 for a complete list of fault codes and corresponding error displays.
  Time stamps use the 24hr HH.MM format, so for example 3:19 PM would display as [15.19]
  Date stamps use the MM.DD format, so for example September 3rd would display [09.03]

	Fault #1 (Latest Fault)	Fault #2 (Previous Fault)	Fault #3 (Oldest Fault)
Fault code: (See Chapter 7)	**F085**	**F088**	**F091**
Time Stamp (HH.mm)	**F086**	**F089**	**F092**
Date Stamp (MM.DD)	**F087**	**F090**	**F093**

Table 5.6.13.a: Fault History Configuration

F085 = Latest Fault Code (Fault #1)
Factory Setting = 0 (No Fault)
Range = 0 – 27
This Function displays the Fault Code of the latest fault event.

F086 = Time Stamp of the Latest Fault
Factory Setting = 00.00 (No Fault)
Range = 00.00 – 23.59 (24hr time format)
This Function displays the time of the latest fault event.

F087 = Date Stamp of the Latest Fault
Factory Setting = 00.00 (No Fault)
Range = 01.01 – 12.31
This Function displays the date of the latest fault event.

F088 = Same as F085 except for the Previous Fault (Fault #2)

F089 = Same as F086 except for the Previous Fault.

F090 = Same as F087 except for the Previous Fault.

F091 = Same as F085 except for the Oldest Fault (Fault #3)

F092 = Same as F086 except for the Oldest Fault

F093 = Same as F087 except for the Oldest Fault

- **5.6.13.b Statistical Data**
  F094 - F097 display information from the Run Time / Elapsed Time meter and Run-Cycle counter.

  Run Time includes Accel, Run, Decel, and Jog operations.

  Run Cycles are counted only when the starter reaches At-Speed mode.

F094 = Run Time, Hours
Factory Setting = 0000
Range = 000.9 - 999.9 hours
Run counts in excess of 999.9 are recorded in F095.

F095 = Run Time, K Hours
Factory Setting = 0000
Range = 0000 - 9999 K hours
0001 in readout means a run time of 1,000 hours.

F096 = Run Counts
Factory Setting = 0000
Range = 0000 – 9999
Run counts in excess of 9999 are recorded in F097.

F097 = Run Counts, 10K Times
Factory Setting = 0000
Range = 0000 - 9999, 10 thousand times
0001 in readout means a run count of 10,000 operations.

Examples:	Overflow Value	Basic Value
Run Time 23,047 Hours	**F095**	**F094**
	0002	**3047**
Run Counts 18,702 Starts	**F097**	**F096**
	0001	**8702**

Table 5.5.15: Statistical Data Examples

Chapter 6 - Start-up

6.1 Basic Startup

Your new ***TE Series*** Soft Starter is factory preset for a wide variety of applications and often can be used with minimal adjustment.

6.1.1 Three Step Process

1. Connect L1, L2, and L3 to power lines and T1, T2, and T3 to motor.
2. Connect control wires and control power.
3. Program motor FLA (F001).

6.1.2 Start-up Parameters and Factory Defaults

Try the initial presets first and then adjust or enable the more advanced features to meet your specific starting needs.

Fn #	Function Name	Factory Setting	Description / Factory Setting
F001	Motor Nameplate FLA.	0	FLA must be programmed for starter to function.
F002	Motor Nameplate Service Factor	1.0 SF	Change only if necessary AND motor is rated over 1.0SF
F003	Overload Class During Start	Class 10	NEMA / UL Class 10
F004	Overload Class During Run	Class 10	NEMA / UL Class 10
F005	Overload Reset	0 (Manual)	0 = Manual
F010	Ramp Profile	1	Ramp 1 and Ramp 2 = Voltage Ramp with Current Limit
F011	Initial Torque	60	60% Initial Voltage
F013	Ramp Time	10	10 Second Ramp (Ramp 1)
F014	Current Limit	350	350% of programmed FLA
F015 – F018	Ramp 2 settings	---	Inactive unless Ramp 2 Input is closed
F019 – F052	Software protection and control features	---	Inactive unless selected
F053	Internal hardware protection features	127	All active
F054 – F059	Timer and counter value readouts	---	Read only
F060	Aux Relay #1	1	Run / Stop
F061	Aux Relay #2	2	At-Speed / Stop
F062	Aux Relay #3	16	Any Trip
F063	Aux Relay Delay	0	No Delay
F065 – F068	Communications	----	Not Used unless without optional Comm Adaptor
F070	Parameter Lock	0	User password disabled
F071	Reset Function	0	Use to reset to default values
F073 – F080	System settings and time clock	---	User choice to adjust clock
F085 – F093	Fault History	---	Read only

Table 6.1.2: Factory Presets

6.2 Start-up Check List

- ☐ Supply voltage matches the rated supply voltage of the unit.
- ☐ Horsepower and current ratings of the motor and unit match or the unit is higher rating.
- ☐ Initial ramp time and torque adjustments have been checked.
- ☐ Power lines are attached to the unit input terminals L1, L2 and L3.
- ☐ Motor leads are connected to the lower terminals T1, T2, and T3.
- ☐ Appropriate control power is applied and/or control connections have been made.
- ☐ "Power On" light located on the front of the unit turns on when control power is applied.
- ☐ Four 7-segment LED readouts are visible.
- ☐ The motor's FLA has been programmed in function F001.
- ☐ The thermal overload is properly set. (Use F003 and F004 to set OL Class.)
- ☐ The motor area and equipment are clear of people and parts before start-up.

6.3 Sequence of Operation

- Apply three-phase power to the unit. The motor should not run until the start command is applied.
- Apply control power and check that the "Power On" LED comes on.
- Status Display should read **[0000.]** showing no current in Phase A (minor flickering of the first digit is common).
- Apply the Run (Start) command. The motor should begin to accelerate. Status display will read Phase A Amps at an increasing rate.
- When the motor reaches full speed, the "At Speed" LED comes on. Status display should show a sharp decrease in Phase-A amps.
- If a Bypass Contactor is present (TE…-BP model), the Bypass Contactor should pull in.
- If the motor does not fully accelerate, decelerates, or stops during the acceleration period, hit the Stop button immediately and open the disconnect line.

If Pump-Flex Decel is programmed in F025:

- Remove the Run Command (or hit the Stop button). At-Speed LED will go out.
- If a Bypass Contactor is present (TE…-BP model), the Bypass Contactor should drop out.
- Status display should read Phase-A amps increasing as motor begins to decelerate.
- Motor should begin to slow down. Status display should begin to show decreasing motor amps.
- When motor reaches Stop Level, starter should turn off. Status display will again show **[0000.]**

If the unit does not follow this operational sequence please refer to the Service and Troubleshooting Guide

6.4 Testing with a smaller motor

- To test the ***TE Series*** starter with a motor which will draw less than 20% of the unit Max Amp rating, you must disable the Phase Current Loss (Running) protection as per instructions in section 5.6.9.a. If this feature is not disabled, the ***TE Series*** will give a Phase Loss Trip after running for 3 seconds at low currents.

Chapter 7 - Fault Conditions

Additional information on Fault Codes and possible causes can be found in the ***Service and Troubleshooting Guide.***

7.1 Fault Codes and Numbers (in History)

A three-character fault code is displayed in the LED display at the time of the trip event. The first two digits indicate the trip condition (see Table 7.1). The third digit is a suffix showing the ***TE Series*** operating mode when the trip occurred. Operating modes are as follows:

Code suffix "A": Acceleration, meaning that the ***TE Series*** was ramping up but had not yet achieved "At-Speed" status (see section 4.2.9.b for a brief description of At-Speed indication).

Code suffix "c": Constant Speed (running), meaning that the ***TE Series*** has reached the At-Speed condition and the motor was running when the trip occurred.

Code suffix "d": Decel or Stop, meaning that ***TE Series*** was either stopped (off, but power applied), or if the Pump-Flex Decel function was enabled, it was engaged in the Soft Stop routine set up by F024-27.

IMPORTANT NOTE:
Fault code SSd may display if there is no output load connection when control power is applied!

In addition to these fault display codes, each trip condition has a corresponding numeric code that is stored in the Fault History (see section 5.6.13.a). These numeric codes follow the display codes exactly. The following Table 7.1 shows Fault Display Codes, Fault Number Codes, LED indicators that would come on with them and descriptions. Additional details are available in the Service and Troubleshooting Guide.

Example: If Function F003 (starting overload protection) is set too low for the size of the load and causes a trip, the code "oLA" will be displayed. Its corresponding number will be entered into the fault history. In this case, the number 0010 will be available for display in the window of function F085 (Fault History). The time the fault was detected is available in Function F086. It is expressed as hh.mm. Therefore, if the "oLA" fault occurred at 10:00 am, F086 would display 10.00. The date the fault occurred is available in Function F087. The date is expressed as mm.dd. If the "oLA" fault occurred on March 1, F077 would display 03.01. If there were no fault conditions in history, the display in F085 would read 0000.

Fault Condition Description	Fault Display Code Readout	Fault Number Code used in History, F085, F088 and F091	LED Indicator
No Full Load Amps entered into F001	**nFLA**		
Over Current during Acceleration	**ocA**	1	Over Current
Over Current during Constant speed	**occ**	2	
Over Current during Deceleration	**ocd**	3	
Phase Loss during Acceleration	**PLA**	4	Phase Loss
Phase Loss during Constant speed	**PLc**	5	
Phase Loss during Deceleration	**PLd**	6	
Line Voltage Loss (no 3 phase prior to start)	**n3Ph**	6	
Over Temperature during Acceleration	**oTA**	7	Over Temp
Over Temperature during Constant speed	**otc**	8	
Over Temperature during Deceleration	**otd**	9	
Over Load during Acceleration	**oLA**	10	Over Load
Over Load during Constant speed	**oLc**	11	
Over Load during Deceleration	**oLd**	12	
Shorted SCR during Acceleration	**SSA**	13	Shorted SCR or no load
Shorted SCR during Constant speed	**SSc**	14	
Shorted SCR during Deceleration or Stop	**SSd**	15	
Shunt Trip during Acceleration	**st**	16	Shunt Trip
Shunt Trip during Constant speed	**st**	17	
Shunt Trip during Deceleration	**st**	18	
Current Imbalance during Acceleration	**IBA**	19	---
Current Imbalance during Constant speed	**IBc**	20	
Current Imbalance during Deceleration	**IBd**	21	
Under Current during Acceleration	**UcA**	22	---
Under Current during Constant speed	**Ucc**	23	
Under Current during Deceleration	**Ucd**	24	
Short Circuit during Acceleration	**ScA**	25	Over Current
Short Circuit during Constant speed	**Scc**	26	
Short Circuit during Deceleration	**Scd**	27	
Ground Fault during Acceleration	**GFA**	28	---
Ground Fault during Constant speed	**GFc**	29	
Ground Fault during Deceleration	**GFd**	30	
Bypass Discrepancy during Acceleration	**BPA**	31	---
Bypass Discrepancy during Constant speed	**BPc**	32	
Bypass Discrepancy during Deceleration	**BPd**	33	
PTC Trip during Acceleration	**PtA**	34	Over Load
PTC Trip during Constant speed	**Ptc**	35	
PTC Trip during Deceleration	**Ptd**	36	
Rotation Trip during Acceleration	**rtA**	37	---
Rotation Trip during Constant speed	**rtc**	38	
Rotation Trip during Deceleration	**rtd**	39	

Table 7.1: Fault code List

Appendix 1 - Ramp Profile Details

The ***TE Series*** offers four different types of starting ramp profiles. Simply select the one that best matches your motor / load requirements. In addition, **two separate ramps** are available that can be selected via contact closure (see section 4.2.5.a), and each one can be set up for any ramp type as shown in the table below.

Ramp 1 Settings				"Ramp Type Selection" from F010	Ramp 2 Settings			
Ramp Type	Initial Torque from…	Ramp Time from…	Current Limit from…		Ramp Type	Initial Torque from…	Ramp Time from…	Current Limit from…
Voltage	F011	F013	F014	1	Voltage	F015	F017	F018
Current	F012	F013	F014	2	Current	F016	F017	F018
Voltage	F011	F013	F014	3	Current	F016	F017	F018
Current	F012	F013	F014	4	Voltage	F015	F017	F018

Table APP 1.1: Ramp Selection Choices and Settings

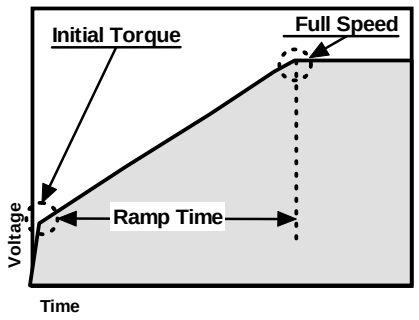


Figure APP 1.1: Voltage Ramp w/o Current Limit

Following are descriptions of the four types of Ramp Profiles

1. Voltage Ramping is the most reliable starting method, since at some point the starter will reach an output voltage high enough to allow the motor to draw full current and develop full torque. This method is useful for applications where the load conditions change frequently and significantly enough to require different levels of starting torque. Examples where this is effective are:

- Material handling conveyers
- Positive displacement pumps
- Drum mixers, grinders etc.

Voltage is increased from a starting point (Initial Torque) to full voltage over an adjustable time period (Ramp Time). To achieve Voltage Ramping, set the Ramp Profile (F010) to 0001 or 0003 (Voltage Ramp), and the Maximum Current Limit setting (F014) to maximum (600%). Since this is essentially Locked Rotor Current on most motors, there will be little or no Current Limit effect on the Ramp profile. Initial Torque setting comes from the Initial Voltage function F011.

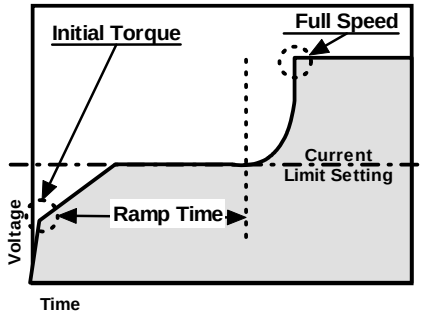


Figure APP 1.2: Voltage Ramp with Current Limit

2. Voltage Ramping with Current Limit works similarly to the above, except adds an adjustable maximum current output. Voltage is increased gradually until the Maximum Current Limit setting (F014) is reached, then held at this level until the motor accelerates to full speed. Then as the current drops below the limit setting, voltage is automatically increased to maximize torque until the ***TE Series*** is At-Speed. This may be necessary in applications where the electrical power is limited. Examples would be:

- Portable or emergency generator supplies
- Utility power near the end of a transmission line or other starting power demand restrictions.

Using Current Limit will override the Ramp Time setting if necessary, so use this feature when acceleration time is not critical. The Ramp Time setting however still determines the slope of the ramp up to the Current Limit setting to apply the softest possible acceleration. To achieve Voltage Ramping with Current Limit, set the Ramp Profile (F010) to 0001 or 0003 (Voltage Ramp), and the Maximum Current Limit setting (F014) to a desired lower setting, as determined by your application requirements.

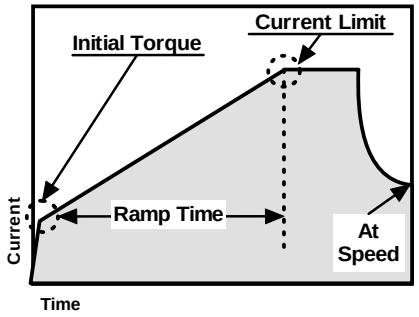


Figure APP 1.3: Current / Torque Ramp

3. Closed Loop Current (Torque) Ramping is good for smooth linear acceleration of output torque. Ramp Time becomes the time from Initial Torque and Current Limit settings. Output torque is constantly updated using an internal PID feedback loop to provide a linear ramp, and therefore the available torque is maximized at any given speed. The best use of this feature is for applications where rapid changes in torque may result in load damage or equipment changes. Examples would be:

- Long overland conveyors where belt stretching may occur.
- Low pressure pumps where slight surges at the end-of-ramp may pose mechanical problems.
- Fans and mixers where blade warping is a problem.
- Material handling systems where stacked products may fall over or break.

This feature can be used with or without the Maximum Current Limit setting.

To achieve Torque Ramping with the ***TE Series***, set the Ramp Profile (F010) to 0002 or 0004 (Current Ramp), and the Maximum Current Limit setting (F014) to the desired level. Initial Torque setting comes from the Initial Current function F012.

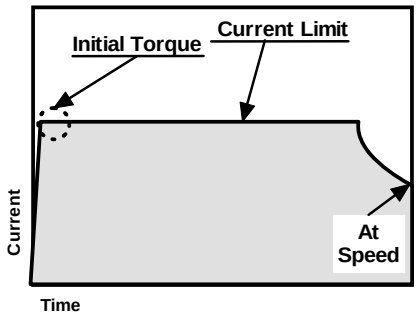


Figure APP 1.4: Current Step Starting

4. Current Limit Only (Current Step) starting means using the Current Limit feature exclusively without the benefit of soft starting by ramping the voltage or current first (also known as **Pedestal Starting**). This will maximize the effective application of motor torque within the limits of the motor. In this mode, Initial Torque is set to maximum and Ramp Time is set to minimum, so the output current jumps to the Current Limit setting immediately. Examples of when to use this mode are:

- Applications with a severely limited power supply
- When starting a difficult load such as a centrifuge or deep well pump
- When the motor capacity is barely adequate without stalling or overloading.
- It is a good choice when other starting modes fail.

Since ramp times are set to minimum, this mode functions in either Voltage Ramp or Current Ramp setting.

Ramp Parameter Descriptions

Following are detailed descriptions of the individual settings that make up each ramp profile.

Initial Torque (Initial Voltage or Initial Current).

These functions set the initial start point of either the Voltage Ramp or Current Ramp as programmed in F010. Every load requires at least some amount of torque to start from a standstill. It is not efficient to begin ramping the motor from zero every time, since between zero and the (WK^2) breakaway torque level, no useful work is being performed. The initial torque level should be set to provide just enough torque to make the motor shaft begin to rotate, enabling the softest possible start and preventing torque shock damage to the mechanical components. Setting this function too high will not damage the starter, but may reduce or eliminate the soft start advantages.

Accel Ramp Time. This Function sets the maximum allowable time for ramping from the Initial Torque setting to either of the following:

1) Current limit setting when the motor is still accelerating, or

2) Full output voltage if the Current Limit is set to maximum.

Increasing the Ramp Time softens the start process by lowering the slope of increase in voltage or current. This should be set to provide the softest possible start without stalling unless you have determined that your application has other considerations. Applications where this setting should be shorter include Centrifugal Pumps, because pump problems may occur as a result of insufficient torque during acceleration through the pump curve.

- **NOTE:**
  Ramp Time is affected by the following conditions:
  1. Current Limit will automatically override the Ramp Time if set to Voltage Ramp (F010=1) and if the motor does not reach full speed while in current limit mode.
  2. An "Anti-Oscillation" circuit built-in to the ***TE Series*** will shorten the Ramp Time if the motor reaches full speed before end of ramp.

Current Limit. This Function sets the maximum motor current that the starter allows during Ramping. It is active in both the Voltage Ramp and Current Ramp modes. As the motor begins to ramp, this feature will set a ceiling at which the current draw will be held. Current Limit will remain in effect until one of the following two events occur:

1. The motor reaches full speed as detected by the At-Speed detection circuit.
2. The Overload Protection trips on Motor Thermal Overload (see Ch.3).

Once the motor has reached full speed, the Current Limit feature becomes inactive.

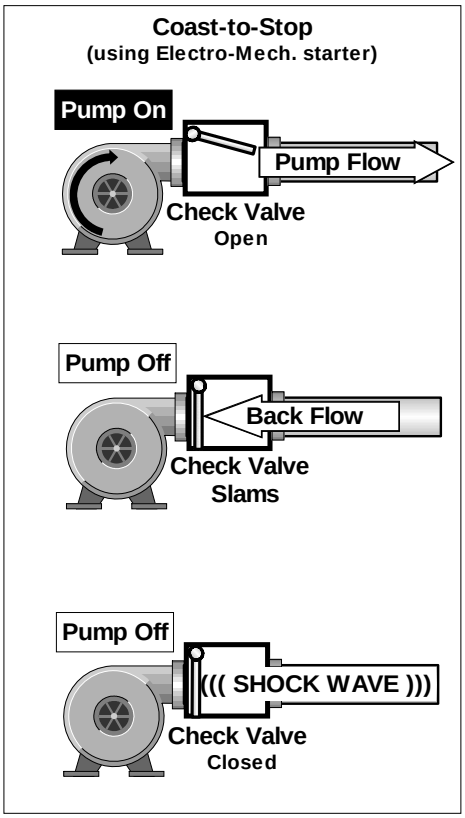
- **In the Voltage Ramp Profile**, the Voltage output is increased until the Current Limit is reached. The Ramp Time is the maximum time it will take for the voltage to increase until the Current Limit setting takes over. Under some load conditions, Current Limit may be reached before the Ramp Time has expired.
- **In the Current Ramp Profile**, output voltage varies to provide a linear increase in current up to the Current Limit setting, and Ramp Time is the time that it will take to get there. A closed loop feedback of motor current allows continuous updating of the output to maintain this ramp profile.

Because most AC induction motors will not start below 200% current, the current limit set point is adjustable down to only 200%.

⚠CAUTION

While in the Start mode there is no maximum Current Limit time. Excessive start time may lead to motor stalling, causing an Overload Trip. If this happens, try raising the Current Limit setting to accommodate your load conditions. If the Current Limit setting cannot be increased, try using Current Limit without ramping features ("Current Limit Only" as described previously).

Appendix 2: Pump-Flex® Decel Mode Application Considerations

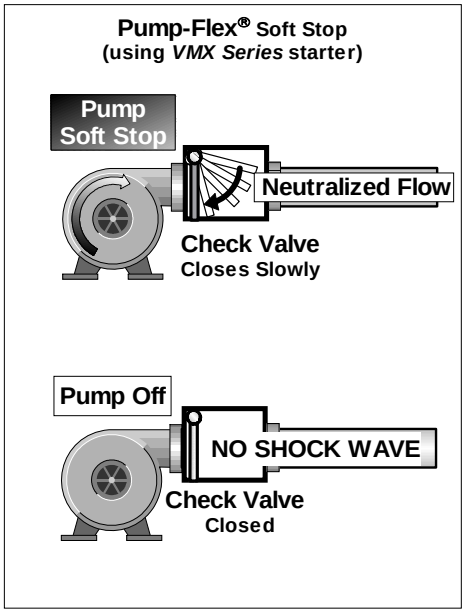


Pump-Flex® Deceleration (Soft Stop) is a unique feature of Toshiba Solid State Soft Starters. It provides a slow decrease in the output voltage, accomplishing a gentle decrease in motor torque during the stopping mode. This is the **OPPOSITE OF BRAKING** in that it will take **longer** to come to a stop than if the starter were just turned off.

The primary use of this function is with centrifugal pumps as a means to reduce the sudden changes in pressure that are associated with "Water Hammer" and slamming of check valves. Decel control in pump applications is often referred to as **Pump Control**.

In a pump system, liquid is being pushed uphill. The force exerted by gravity on the column of liquid as it goes up hill is called the "Head Pressure" in the system. The pump is sized to provide enough Output Pressure to overcome the Head Pressure and move the fluid up the pipe. When the pump is turned off, the Output Pressure rapidly drops to zero and the Head Pressure takes over to send the fluid back down the hill. A "Check Valve" is used somewhere in the system to prevent this (if necessary) by only allowing the liquid to flow in one direction.

Kinetic energy in that moving fluid is suddenly trapped when the valve slams closed. Since fluids can't compress, that energy is transformed into a "Shock Wave" that travels through the piping system looking for an outlet in which to dissipate. The sound of that shock wave is referred to as "Water Hammer". The energy in that shock wave can be extremely damaging to pipes, fittings, flanges, seals and mounting systems.



SOLUTION:

By using the Pump-Flex® Decel feature of the ***TE Series***, the pump output torque is gradually and gently reduced, which slowly reduces the pressure in the pipe. When the Pump Output Pressure is just slightly lower than the System Head Pressure, the flow slowly reverses and closes the Check Valve. By this time there is very little energy left in the moving fluid and the Shock Wave is avoided. When the output voltage to the motor is low enough to no longer be needed, the ***TE Series*** will end the Pump-Flex® Decel cycle and turn itself off.

⚠CAUTION
Decel is THE OPPOSITE of braking. Enabling the Decel feature will make the motor take LONGER to stop than if it were simply turned off.

Setup and Use
Pump systems vary greatly. To accommodate this, the **Pump-Flex®** Decel control feature is designed to provide complete flexibility in how the deceleration process takes place by using the following settings.

Decel begins when a Stop command is given (or the Run command is removed). If there is a Bypass Contactor, it will open immediately, putting the power control back to the SCRs.

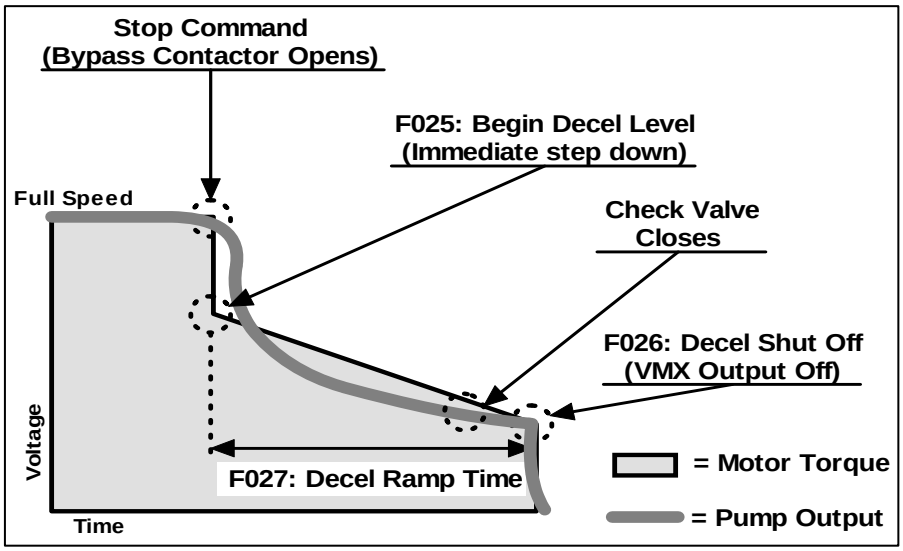


Figure APP2.2: Pump-Flex Decel Graph

F024 = Deceleration Ramp
Factory Setting = 0 (Disabled)
Range = 0 – 2

When F024 = 0, the deceleration feature is **disabled**.

When F024 = 1, the deceleration feature is **enabled** AND the overload protection feature (from F003 - F005) remains active. When a Stop command is given, the starter begins to apply Decel voltage. However, if an overload trip occurs, the starter ceases applying Decel voltage and the motor coasts to a stop to prevent additional motor heating and potential motor damage.

When F024 = 2, the deceleration feature is **enabled** and deceleration will **continue even when an overload condition trips**. This is to be used only when the risk of damage due to an uncontrolled shutdown is considered worse than the potential damage to the motor.

⚠WARNING

Setting F025 = 2 presents significant risk of over-heating the motor beyond its design limits which could result in motor damage and fire hazard. Do this only in circumstances where the potential for mechanical damage outweighs the risk of motor damage.

- **NOTE:**
  The PTC Input will act as an Overload trip (disable), however it

ALWAYS shuts the starter down ***WITHOUT*** Decel (as in setting 1 above) even if F025 is set to 2.

F025 = Begin Decel Level (BDL)
Factory Setting = 60%
Range = 0 - 100% of line voltage
Use to drop voltage to a level where there is a noticeable effect on motor torque during Decel mode. Generally, systems with high head pressure need to start Decel near the top of the ramp (85-95%). Low head systems can drop to lower settings (50-60%). System conditions vary greatly by pump type, pipe size and system head. Some experimentation with settings may be necessary.

F026 = Decel Shut Off Voltage
Factory Setting = 30%
Range = 0 to (BDL -1)%
Sets the level where the starter is turned off, corresponding to where motor torque during Decel is no longer effective. Always set this function lower than the setting of F026, Begin Decel Level (this function is restricted from being less than F026 minus 1%). This function is used to shut the motor off once the check valve closes. Again, because systems vary greatly this setting may require adjustment several times. If you cannot hear or see the check valve close, observe fluid pressure or flow if available.

F027 = Decel Ramp Time
Factory Setting = 10 seconds
Range = 1 - 60 seconds
Sets the maximum time for the deceleration ramp to go from the Begin Decel Level setting (F026) to the Decel Shut Off Voltage (F027). This function is used to dampen the effect of reducing pump torque as much as possible. If the check valve still slams at the end of ramp, try extending this time function a little. Since motor heating increases as voltage is lowered, the setting should not exceed the time necessary to achieve the deceleration effect.

- **NOTE:**
  When using the Decel function, count these cycles as additional “starts” when determining maximum starts-per-hour.

Other Applications:
Another common application for Decel control is on material handling conveyors as a means to prevent sudden stops that may cause products to shift, fall over or to bump into one another.

In overhead crane applications, Soft Stopping of the Bridge or Trolley can prevent loads from beginning to over swing on sudden stops.

Appendix 3: Parameter Lock / User Password Instructions

Provides users with the ability to prevent unauthorized operators from making changes to the programmed functions. **If you do not need to take advantage of this feature, do not enter anything into this function.** The factory default is disabled, and no Password is necessary to make changes to the program.

When any value other than 0000 is entered into this Function, the Parameter Lock is enabled and that number becomes the User Password. From that point forward, it will be necessary to enter the User Password in this Function prior to making changes in any programmed function, including this one. When the Parameter Lock has been enabled, attempts to alter the program will result in the display reading [**Err]** whenever the **[READ/ENTER]** key is pressed.

To alter the program after the Parameter Lock has been enabled, go to Function **F070** and enter the correct user Password. The display will read an encoded value representing the existing password. As soon as you press the first Arrow key, the display will change to **[0000]** and start showing the actual value of your password entry. When the **[READ/ ENTER]** button is pressed, the display will read **[PASS],** indicating that the User Password is correct and the system is unlocked. You will have 5 minutes in which to make a change in the program. This 5-minute window resets whenever any key is pressed, so it floats to give you 5 minutes after the last entry. After 5 minutes of no keypad activity, the Parameter Lock is reinstated with the current user Password. Subsequent changes will require re-entering the User Password.

To change the User Password or to disable the Parameter Lock function, enter the programmed User Password first, and then set Function F070 to 0, disabling the Parameter Lock. If you do not re-enter the Password or enter a new user password, the Parameter Lock feature will remain disabled. If you enter a different number into this Function, the new number becomes your new User Password. Existing passwords are encoded to “hide” them in the display.

CAUTION
DO NOT LOSE YOUR PASSWORD.
If the password has been lost or forgotten, contact Toshiba for assistance.

Example: Figure App 3
Enabling Password Protection / Parameter Lock

Starting from the Status Display Mode, no previous function number entered, no existing password...

Press the Fn key.

Displays F001 to indicate the beginning of the function list.

Press the LEFT arrow key

Selects the second digit (from the right). NOTE: do it in this order because F000 would not have been a valid number

Press the UP arrow key seven times (7X)

Changes the function code to F071.

Press the RIGHT arrow key

Selects the first digit (from the right).

Press the DOWN arrow key

Changes the function code to F070.

Press the Read Enter key

The default display will show **[3552]** as long as no password has been previously entered. This is the default code for "0000", meaning that there is no password**. As soon as you press the first Arrow key, the display will change to [0000]** and begin showing the actual value of your password entry. Any initial display other than **[3552]** signifies that a password already exists. This means that you will need to change, rather than enter a new one (see below).

Use the UP arrow and the LEFT arrow keys…

to display the password you desire (Valid range is 0000 to 0999). In this example, 0123 has been selected.

Press the Read Enter key

The display will flash **[End]** to confirm you have entered a password. Then it will return to displaying thee Function #.

Example: Setting a Password

Using Password 123

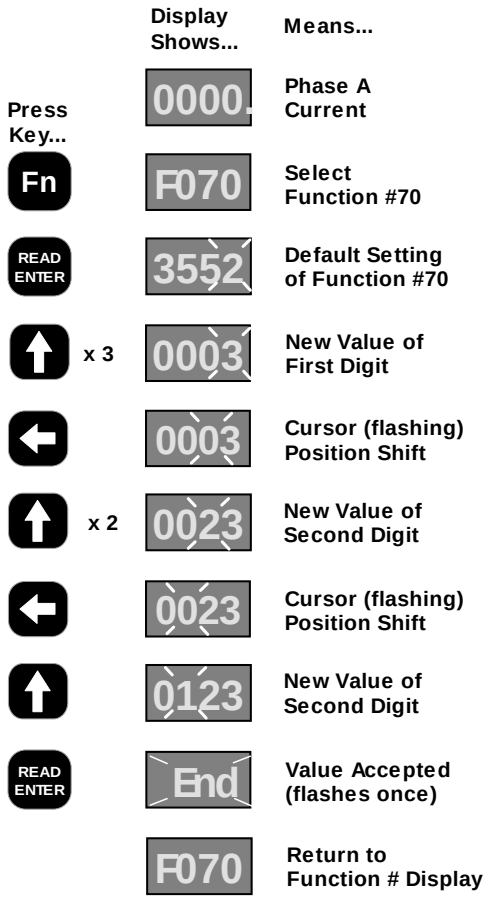


Figure App 3:
Entering a Password

Changing passwords:

To change an existing password, the steps are essentially the same as outlined above, except you must first enter the existing password. At F070, press the **[READ/ENTER]** key to reveal the encoded password (you must know that password before it can be changed). Use the Arrow keys to enter the password. As soon as you press the first Arrow key, the display will change to **[0000]** and start showing the actual value of your entry. When you get to the existing password, press the **[READ/ENTER]** key again. The display will flash **[PASS]** to indicate that the password was accepted. If it flashes **[Err]**, you have entered the wrong password.

Resetting to Factory Defaults using F071 will NOT reset the password.

Disabling Password Protection / Parameter Lockout

Changing function F070 to **[0000]** will disable the user password. If the initial display reads **[3552],** the password is already set to **[0000].**

Appendix 4: Process Control Timer Functions

F030 through F039; Overview of Process Timer Control and Time Clock Controller Features*:*
The following special functions allow your ***TE Series*** starter to operate automatically from an internal Process Control Timer and Time Clock Controller (TCC) using a real time clock. The Process Control Timer (F030 and F031) can be used independently or together with the TCC feature (F032-39). The TCC requires using the Process Control Timer to provide for Start commands (depending on the selected mode). Time progression and clock values can be read in the Status Screen (see section 5.3.1).
A convenient chart at the end of this appendix shows all settings and interactions.

F030 = Process Control Timer Selection
Factory Setting = 0 (Disabled)
Range = 0, 1, 2
This function enables a **Process Control Timer**, which offers two operating modes (Minimum Batch Run Timer and Permissive Run Timer), selected by entering 1 or 2 here.

F030 = 1: Minimum Batch Run Timer
In this mode, the **Process Control Timer** engages that the motor will run for a minimum amount of time, regardless of whether someone stops it intentionally, or power fails and returns. When selected to Minimum Run Timer, it begins counting down after a Start command. The Time Value is set in **F031.** When the time value reaches **[0000]** the starter will turn off, even if the Start command is still closed and without a Stop command.

To **Reset** the timer in this mode, give a Stop command after the timer has expired. If using the TCC (F032), reset is automatic when completed and no other Run command is present.

If a Stop Command, power failure or Fault trip occurs during timed operation, the **Process Control Timer** is suspended and maintains its value. When the starter is then restarted, the timer resumes counting down to ensure that the motor has run for the programmed amount of time (finishes the batch).

Use this function to ensure that a load operates for a minimum amount of time regardless of other circumstances. **Examples** would be:

- **Irrigation pumps** where a specific amount of pumping time is required even if the pump is shut down on a low level alarm and then resets, or power fails and returns.
- **Mixers** that need to agitate for a specific amount of time yet may be shut down when power fails or as product is added.
- **Aeration Blowers** that must be run for minimum amounts of time to ensure that proper aeration (contact time) has been provided to a tank.

- **NOTE**:
In **2-wire control systems** where the Run command is maintained, the starter will automatically restart after a power failure or a Trip is reset. Use appropriate warnings as mentioned in section 3.1.3.b (see the following F032 description for an exception to this).
In **3-wire control systems**, a new Start command will be required to restart the starter.

Example: Figure App 4.1
Minimum Run (Batch) Timer

An irrigation pump needs to come on when called for by a soil moisture control system, and run for ½ hour. If during that ½ hour the well level drops and shuts the pump down, the pump needs to restart when the well recovers and finish the ½ hour pump time.

Set F030 to [0001] for Minimum Run Timer.
This will ensure that when the well level recovers and resets the run command, the starter will finish the time sequence.

Set F031 to [0030] (minutes)
This is the Run Time that ensures the proper amount of irrigation getting to the crop.

(Not Shown)

Ensure F032 is set to [0000] for One Shot
This will allow the Start command provided by the external control system to engage the starter at any time it is required.

(Another example of this function used with the Time Clock Controller is provided further on)

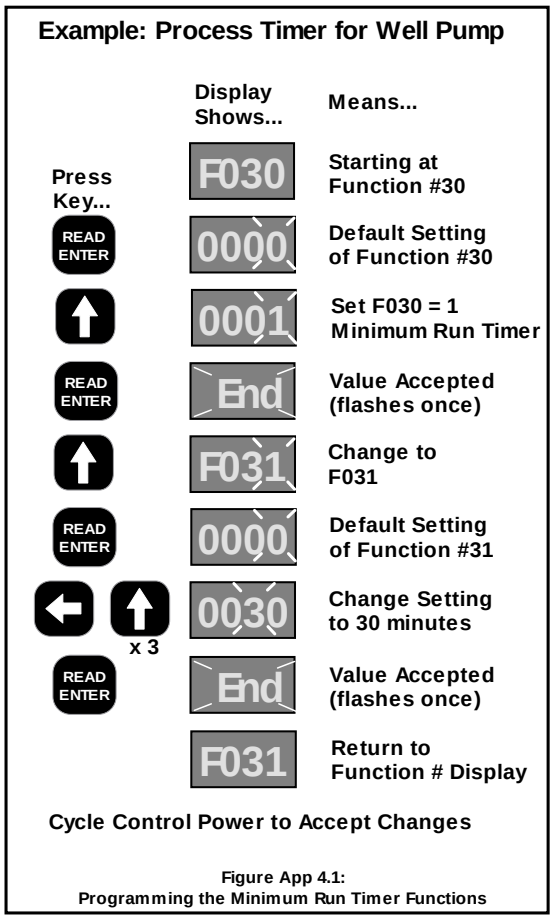


Figure App 4.1:
Programming the Minimum Run Timer Functions

- **NOTE on interaction with other functions:**

  When used with F028 (Auto-Restart Delay), the Minimum Batch Timer will not resume counting down until F028 has expired and the starter has restarted. When used with **3 wire control**, it may be necessary to maintain a Start Command until after F028 has expired, or repeat it if momentary.

  When used with F049 – F050 (Lockout Protection features), the Minimum Batch Timer will not resume counting down until those settings have been satisfied and the ***TE Series*** starter has restarted. When used with **3-wire control**, it may be necessary to maintain a Start Command until after they are satisfied, or repeat it if momentary.

  When used with the Pump Flex Decel feature, the Decel Time (F027) is counted as part of the Batch Run time for this feature.

F030 = 2: Permissive Run Timer.
In this mode, the **Process Control Timer** engages differently according to the settings of the Time Clock Controller (TCC).

When the TCC is set to 0 (using "One Shot" operation), the Process Control Timer begins counting down after the first Start command. Subsequent stop and start commands have no further affect on the timer status and can be used to fully control the starter. When the timer finishes (F031 = **[0000]**), the starter will shut off. Upon the next Start command, the timer will reset and begin counting down again. In 2 wire control systems, the starter will shut off even if the Run command is still closed, and will only reset after the Run command has been cycled (opened and reclosed).

Use this function in *without* the Time Clock Controller (One-Shot mode) to ensure that a load only operates *for a maximum* of the programmed amount of time, beginning with the first Start command. **Examples** would be:

- **Pumps** where the failure of a stop float may lead to dry run conditions if allowed to operate too long, or when the pump only needs to run when someone is present, but operate automatically via float switched (pump-out for service).
- **Ventilation Blowers** where operation is controlled by a manual switch but may be inadvertently left on when someone leaves.

When the TCC is set for 1 through 8 (using Start Event Cycles), the timer begins counting down immediately **when a Start Event is activated**. Any Start / Stop Command that is given to the starter during this time will work normally. When the timer finishes (F031 = **[0000]**), the starter will shut off, and **Start / Stop commands will no longer function until the next Start Event Cycle (SEC)**. In 2 wire control systems, If a Run command is already present when the SEC occurs, it will make no difference and the starter will start.

Reset of the **Permissive Run Timer** will occur only when the next Start Event Cycle is activated by the Time Clock Controller, or when changes are made to programming (see NOTE on programming changes (see "Important NOTE" on page 80). Loss of control power without program changes will NOT reset the time.

Use this function in conjunction with the Time Clock Controller to ensure that a load only operates during the programmed amount of time, beginning with the Start Event Cycle. **Examples** would be:

- **Air compressors** where leaking of air lines during normal downtime causes the compressor to run unnecessarily
- **Irrigation pumps** where operation during parts of the day is undesirable.
- **Energy Savings** to prevent operation when Time-of-Use (TOU) metering discounts are provided to promote conservation.

Example: Figure App 4.2
Permissive Run Timer

An air compressor controlled by a pressure switch feeds a large air distribution system that has small normally insignificant leaks. If left on over night when the system is not in use, leaks drop the air pressure and the compressor cycles on and off even though the facility is unoccupied, wasting energy.

Set F030 to [0002] for Permissive Run Timer.

This will ensure that if nobody remembers to shut the compressor off, it will not run when the facility is shut down.

Set F031 to [0600] minutes (10 hours)

This is the longest Run Time after which the starter will automatically shut down. This ensures that it will not restart after the time expires and until a new Start Event occurs.

(Not Shown)

Ensure F032 is set to [0001] for Every Day, and F033 is set to correspond to work start time (or 5 minutes prior)

This will allow the Run command provided by the pressure switch to engage the starter any time it is required after the shift begins.

With this setting, the compressor will start whenever the pressure switch calls for it after the Start Event set by the Time Clock Controller, but if forgotten it will shut itself off after 10 hours. If power is turned off or lost during those 10 hours, the timer is not cleared or reset, so even if it is turn back on 1 minute before the timer expires, it still shuts off at the end of that 10 hour period.

Example: Process Timer for Compressor

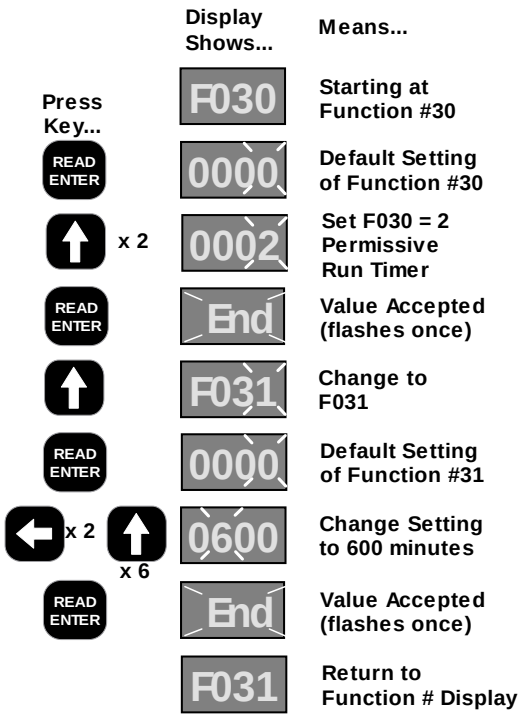


Figure App 4.2:
Programming Permissive Run Timer Functions

NOTE:

If the **Process Control Timer** (F030) is set for Minimum Batch Timer (value of 1), and the next Start Event Cycle passes without a Start command, the previous event will be ignored in favor of the new one.

If a **Process Control Timer** setting from F031 is so long that it overlaps a Start Event Cycle setting in F032-F039, the original timer value becomes invalid. The new Start Event Cycle reloads the value of F031 and begins counting down again from the beginning.

F031 = Process Timer Value
Factory Setting = 1
Range = 1 – 9999 minutes

This function loads a value into the **Process Control Timer** above. When initialized, the value counts down towards 0. F030 sets the operating mode and reset functions for this timer:

The value of this timer can be read directly in the main Status Screen (see section 5.3.1). When the **Process Control Timer** has been enabled in F030, the Status Screen display for the value will flash once per second while timing. When completed, it will stop flashing and read **[0000]**.

- **IMPORTANT NOTE: When F030 or F031 is changed in program mode, the timer will <u>not</u> respond to the new settings until after control power has been cycled (off and back on again).**

F032 = Time Clock Controller (TCC)
Factory Setting = 0 (One Shot)
Range = 1 - 8 settings
This function is used to select the operating mode of the 24hr / 7 Day **Time Clock Controller (TCC)**.

F032 = 0 operates the SEC in a "One-Shot" mode (factory default setting). When set to 0, the Process Timer (F030) responds only to each ***NEW*** hard-wired START input command. **Use this setting to allow the Process Control Timer to operate without the TCC.**
For safety purposes when using 2 wire control systems in this mode only, if power fails and the START/RUN command is present when power is restored, the starter will ignore this command until the input is cycled Off and back On (terminals TB1-1 and 3 are opened and reclosed).

For automatic operations, F032 can also set the number of days in which the TCC will repeat a **Start Event Cycle (SEC)**. Each Start Event Cycle consists of from 1 to 7 Start Events as programmed in F033 through F039 below. Start Events can be non-sequential (see NOTE below).
F032 = 1 operates the SEC every day of the week.
F032 = 2 operates the SEC every 2 days (every other day)
F032 = 3 operates the SEC every 3rd day.
F032 = 4 operates the SEC every 4th day.
F032 = 5 operates the SEC every 5th day.
F032 = 6 operates the SEC every 6th day
F032 = 7 operates the SEC 1 day per week.
F032 = 8 operates the SEC for a single 24HR event, non-repeating. Use this for testing or for "walk away" operations that need to run after you leave but not again.

Start Event Cycles allow the use of a Start Command (2-wire or 3-wire) ONLY AFTER the time of the Start Event has passed (logic state AND). In a 3-wire control system, this is similar to having an Enable switch in series with the Stop button. In a 2-wire control system, this is similar to having and Enable contacts in series with the Run contact. The Stop Button (or opening the Run contact) will always work to shut down the ***TE Series*** starter. If F032 is set to anything other than 0, the normal Start – Stop functions will no longer work except as shown above.

Each Start Event is a timed operation based on the Process Timer settings in F030 above.

⚠CAUTION
If F030 = 0 (Disabled), the TCC will be ignored. So if F032 = 1-8 and F030 = 0, the starter will not operate!
Make sure that if F030 = 0, F032 = 0 as well.

F033 = Event #1 Start Time
Factory Setting = OFF
Range = 00:00 through 23:59, or OFF
This function is used to select the start time for Event #1 in the TCC above. Once given a Start command after this event time, the starter will run the motor according to the selections entered into F030 and for the time entered into F031.

F034 = Event #2 Start Time Same as above, except for event #2

F035 = Event #3 Start Time Same as above, except for event #3

F036 = Event #4 Start Time Same as above, except for event #4

F037 = Event #5 Start Time Same as above, except for event #5

F038 = Event #6 Start Time Same as above, except for event #6

F039 = Event #7 Start Time Same as above, except for event #7

- **NOTE:**
  Start Events are completely independent of one another, and can be programmed in any order. For instance, the Start Time in F037 can be earlier than the Start Time in F033. This allows easier alterations or additions of new Start Times after a unit is already installed.

Fn#	Function Type	Setting	Function Description / Range	Timer Initiated By…	Motor Starts When…	Motor Stops When…	Timer Reset When…
F030	Process Control Timer Mode	0	No Process Control Timer operation (default setting from factory)				
		1	Minimum (Batch) Run Timer (works the same with or without TCC control)	Start command and/or TCC	Start command	Time Expires, Trip, or Stop Command	Time Expires **+** Stop command only
		2	Permissive Run Timer, without TCC (F032 =0, "One Shot") Permissive Run Timer, with TCC (F032 = 2 thru 8)	Start command TCC Start Event only	Start command		Time Expires Next SEC only
F031	Process Timer Value	Run Time Value	Timer value setting used by F030 Range: 1 – 9999 minutes (166.65 hours)	---	---		Per F030 setting
F032	24 hr / 7 day **T**ime **C**lock **C**ontroller	0	One-Shot, follows Start command only	Start command	Start command	Per F030 setting	Per F030 setting
		1	Loop the Start Even Cycle (SEC) daily	24hr Real Time Clock on day of program change	Per F030 setting	Per F030 setting	Continuous unless program is changed
		2	Loop the 24hr SEC every other day				
		3	Loop the 24hr SEC every 3rd day				
		4	Loop the 24hr SEC every 4th day				
		5	Loop the 24hr SEC every 5th day				
		6	Loop the 24hr SEC every 6th day				
		7	Loop the 24hr SEC one day per week				
		8	Single 24hr SEC, without repeating (until programmed again)				Change of Program
F033	Event #1	Start time	24hr TCC Start Time for Event #1	F032 =1-8			Continuous unless program is changed
F034	Event #2	Start time	24hr TCC Start Time for Event #2				
F035	Event #3	Start time	24hr TCC Start Time for Event #3				
F036	Event #4	Start time	24hr TCC Start Time for Event #4				
F037	Event #5	Start time	24hr TCC Start Time for Event #5				
F038	Event #6	Start time	24hr TCC Start Time for Event #6				
F039	Event #7	Start time	24hr TCC Start Time for Event #7				

Chart APP 4.1 Process Timer and TCC Operations Logic Chart

- **NOTE:**
  These functions may interact with the Coast Down Lockout (F048), Stars-per-Hour Lockout (F049), Minimum Time Between Starts (F050), Auto-Reset (F052) and Restart Delay Time (F028) functions if enabled. Be sure to read and understand descriptions of those functions, then check settings before using the **Process Control Timer.**

Example: Figure App 4.3
Time Clock Controller with Minimum Run Timer

An irrigation pump fed from a well with a single float level control needs to come on every other day at 5:30 PM, and run for ½ hour. If during that ½ hour the well level drops and shuts the pump down, the pump needs to restart when the well recovers and finish the ½ hour pump time.

Set F030 to [0001] for Minimum Run Timer.

This will ensure that when the well level recovers and resets the run command, the starter will finish the time sequence.

Set F031 to [0030] (minutes)

This is the Batch Time that ensures the proper amount of irrigation getting to the crop.

Set F032 to [0002] for Every 2nd Day

This will begin the Start Even Cycle on the day of programming and every other day from then on.

Set F033 to [17.30]

This is the 24HR time value representing 5:30 PM. At this time, every other day, the ***TE Series*** starter will automatically start (provided the Stop float in the well is closed) and run for 30 minutes as programmed in F030.

If the pump needs to come on again at 7:00 PM, program F034 to **[19.00].** If later on it is needed to come on at 6:00 AM as well, simply change any other unused start time, i.e. F038 to **[06.00].** Even though this is Event #6 and the lower numbered events had later start times in the program, the starter will execute #6 on time in the next available cycle.

If the pump needs to come on every day, program F032 to **[0001].**

Example: Process Timer and TCC for Irrigation Pump

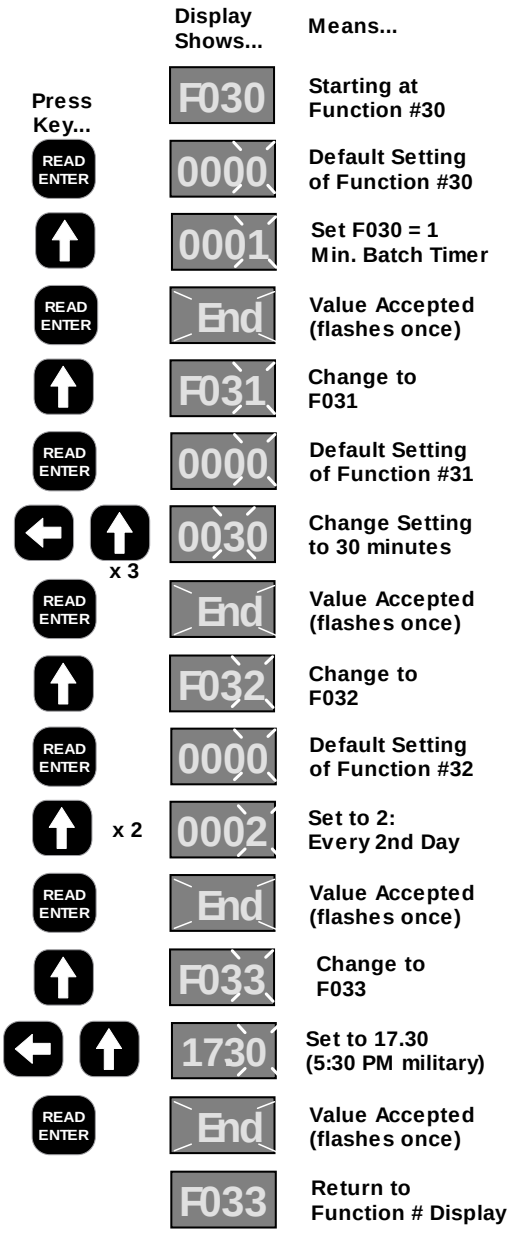


Figure App 4.3: Programming Timer Functions

- **NOTE:**
  If programming is entered AFTER the set time value, the TCC will wait until the next valid time before executing (i.e. if you entered the above example program changes at 5:35 PM, the pump would not come on automatically until 5:30 PM 2 days from now).

Appendix 5 – External Overload Relay Applications

Your ***TE Series*** starter comes equipped with a very intelligent internal electronic overload protection system, and does not need an external Over Load Relay (OLR). There are instances however where external OLRs are needed or desired because of the application. These fall into three categories; Higher Level Protection systems, Redundant Backup applications and Special Motor applications.

- **NOTE:**
  If the Decel Function is activated (F024), additional consideration must be put into determining how the starter is to operate in the event of an Over Load Trip. See Section 5.6.5 for issues regarding this application.

HIGHER LEVEL PROTECTION SYSTEMS

Because of a desire for uniformity and/or operator familiarity in some facilities, Motor Protection Relays or other coordinated OEM protection systems may be used in lieu of the ***TE Series*** protection (even though most of the features are the same or better). In these instances the ***TE Series*** Over Load protection can simply be turned off, deferring protection to the external devices. Care should be taken however to ensure that the external device is properly wired into the starter control circuit to facilitate shutdown of the motor. The ***TE Series*** provides a PTC input that can be wired to the NC aux contact of the external device so that a trip will still shut down the ***TE Series*** and be annunciated on the display. See section 4.7.2.a for more details on using the PTC input.

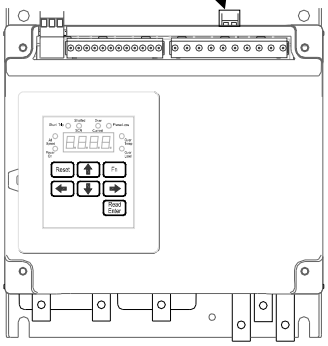
REDUNDANT BYPASS STARTER APPLICATIONS:

In some applications, it may be necessary to provide an independent means of starting and protecting the motor should be ***TE Series*** starter become inoperable. If this were the case, the **Bypass Contactor** could be used for Across-the-Line (D.O.L) starting of the motor. The ***TE…BP*** version with Integral Bypass Contactors is designed for that possibility, as long as the starter is properly selected when ordered. To do so, select the starter based upon the ATL (Across-the-Line) selection chart so that the contactor is rated for ATL duty instead of the normal Shunt Duty (see section 1.2.3 for Selection charts).

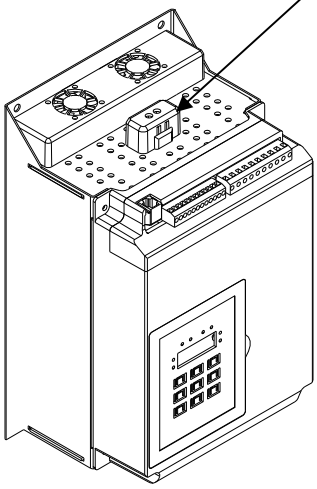
Under normal operations, the Bypass Contactor is controlled internally by the ***TE Series*** PC board and an internal pilot relay. For redundant backup purposes however, terminals B1 and B2 of TB4 are provided for field connection of a dry contact closure in parallel to the pilot relay contact, allowing control even if the electronics are out of service. AC control power must still be applied to TB2 terminals A1 and A2, but no other electronics or power supplies need to be functioning. It is in this instance that an external OLR must be added to the motor power circuit and wired into that coil control circuit. TB4 is located in different areas of each frame size in the ***TE Series***. Refer to the following diagram for the location on your unit.

TE Bypass Control Terminal Location Diagrams

Bypass Control Terminals 18 - 48A Units

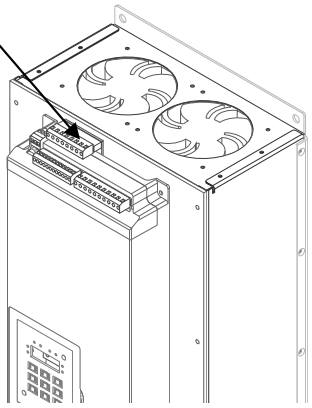


Bypass Control Terminals 62 - 160A Units



NOTE:
Use these terminals only when separate control of the Bypass Contactor is necessary

Bypass Control Terminals: 210 – 550A with or without integral bypass



Appendix 5 (cont.) External OL Relay Applications

Across-the-Line (Direct-on-Line) Bypass

A suggested control schematic is shown below for using the ***TE …-BP Series*** rated for Across-the-Line Bypass with an External Overload:

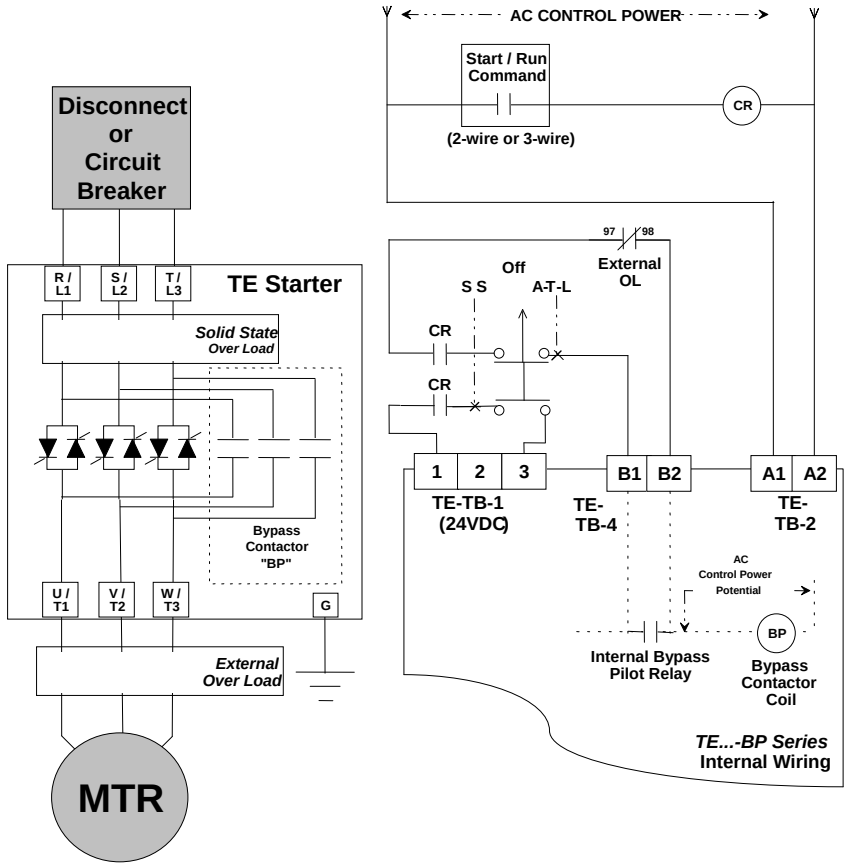


Figure APP5.2: TE Wiring for Across-the-Line Bypass Operation with External Overload Relay (Only the terminals necessary for this operation are shown)

In this example:

The Start / Run command (2-wire or 3-wire) energizes a control Relay "CR". If the selector Switch is in the "SS" (Soft Start) position, the contact of CR closes the 24VDC control signal to TB1, terminals 1 and 3 of the ***TE Series,*** which begins ramping. When At-Speed status is reached, an internal Bypass Pilot Relay is used to close the Bypass Contactor. While in this mode, the ***TE Series*** CPU provides full motor protection, even when the Bypass Contactor closes.

When the Selector Switch is placed in the "A-T-L" (Across-the-Line) position, a 2nd isolated contact of CR is used to close the circuit between B1 and B2 of TB4 which are internally connected in parallel to the Bypass Pilot Relay contact in the Bypass Contactor coil circuit. Since the ***TE Series*** electronics may be out of service, an External Overload is added which only works in this mode and protects the motor by dropping out the connection between B1 and B2.

⚠CAUTION

The circuit on TB-4 is at the same potential as the AC control voltage, but should not be directly connected to it. PC board damage may result.

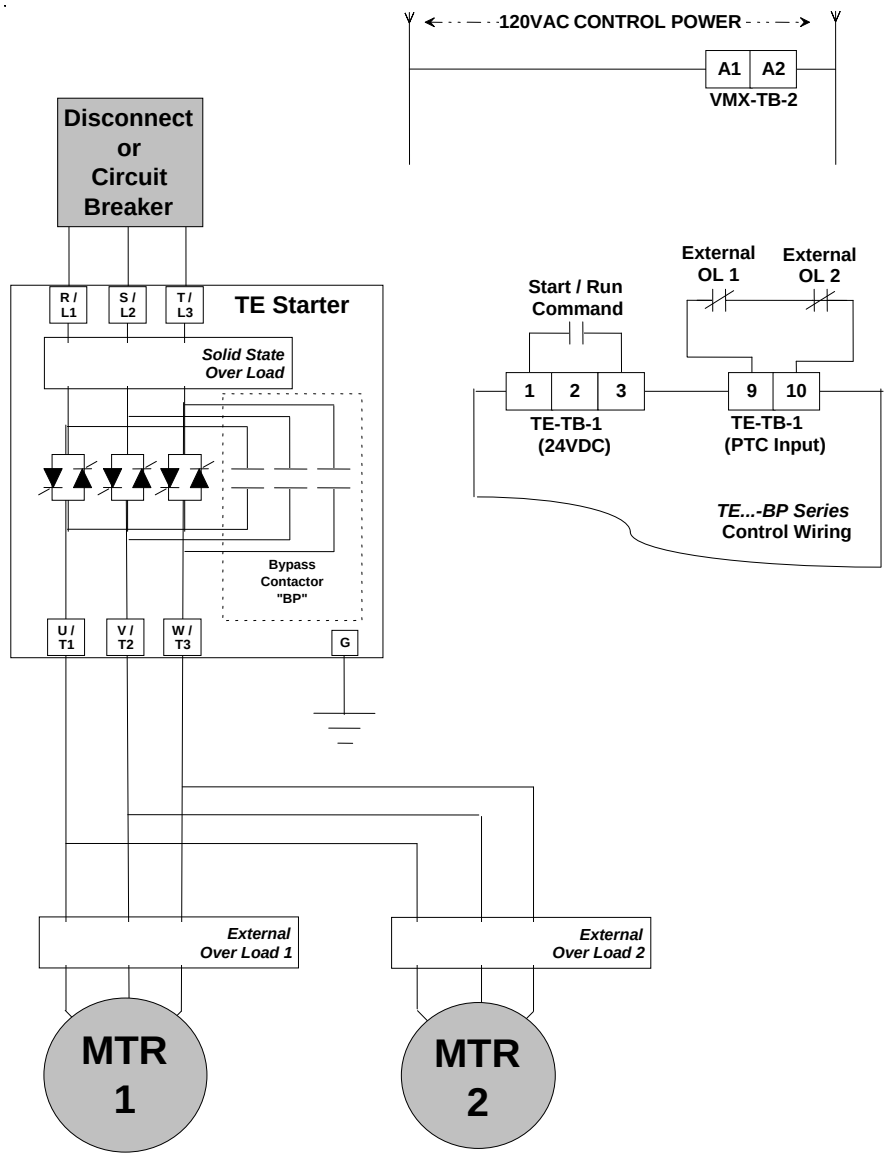
Appendix 5 (cont.) External OL Relay Applications

SPECIAL MOTOR APPLICATIONS

Multiple Motors

When more than one motor is connected downstream from the ***TE Series*** starter, the internal electronic overload protection cannot provide proper protection of the individual motors. Codes require the use of separate OLRs for each motor, which would need to be external devices.

In these instances the ***TE Series*** Over Load protection should be turned off, deferring protection to the separate OLRs. Care should be taken to ensure that the External OLR is properly wired into the starter control circuit to facilitate shutdown of the motor. The ***TE Series*** provides a PTC input that can be wired to the NC auxiliary contact of the external OLR so that a trip will still shut down the ***TE Series*** and be annunciated on the display. Multiple OLRs would then be wired in series for the same effect. See **section 4.7.2.a** for details on using the PTC input.

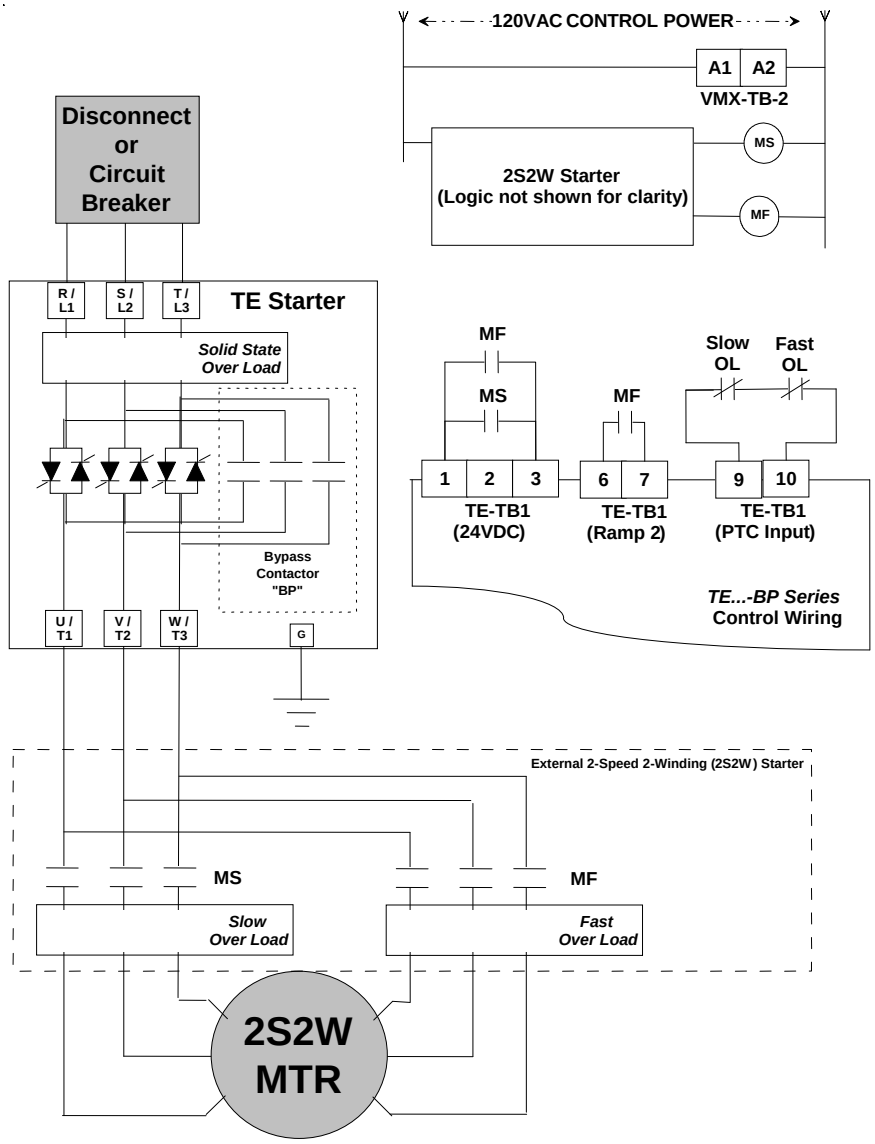


Appendix 5 (cont.) External OL Relay Applications

SPECIAL MOTOR APPLICATIONS

2S2W Motors

2 speed / 2 winding motor applications require a separate OLR sized for each set of windings. These would need to be external OLRs.



In this example:

The ***TE Series*** is used ahead of an *existing* 2S2W starter, which already has separate OLRs for each speed. Dry Aux. contacts of the 2S2W starter are used to provide a Run command to the ***TE Series*** so that all existing controls can be used. In addition, another dry Aux. of the Fast contactor is used to select Ramp 2. When started in Slow, Ramp 1 (default) is used. If started in Fast, different ramp settings are necessary so Ramp 2 is used. (See section 4.2.5.a for Dual Ramp info.)

Either OLR will trip the *TE Series*, which will display [Ptc] and light the "Overload" LED.

Appendix 6 - Soft Starter Settings Record

The following chart may be used to record the changes made to the factory settings.

Fn #	Group	Function Description	Adjustment / Display Range	Setting Increments	Factory Setting	Setting	Setting
F001	Motor and Overload Info.	Motor Nameplate FLA FLA must be programmed for starter to function.	50-100% of Max Amp Rating. Upper limit of range automatically adjusts downward as Service factor is increased.	1 amp	0		
F002		Motor Nameplate Service Factor	1.00 - 1.30 SF	0.05	1.0 SF		
F003		Overload Class During Start	NEMA / UL Class 5 - 20	5	Class 10		
F004		Overload Class During Run	NEMA / UL Class 5 - 30	5	Class 10		
F005		Overload Reset	0 = Manual 1 = Auto 2 = Disabled Overload	1	0 (Manual)		
F006-9		Reserved for factory use					
F010	Starting and Stopping Modes	Ramp Type Selection VR = Voltage Ramp CR = Current PID Ramp 1 = Ramp 1, 2 = Ramp 2	Setting 1 = VR1 + VR2 Setting 2 = CR1 + CR2 Setting 3 = VR1 + CR2 Setting 4 = CR1 + VR2	1	1 VR1+VR2		
F011		Initial Torque (VR) of Ramp 1	0-100% Line Voltage	1%	60%		
F012		Initial Torque (CR) of Ramp 1	0-600% Motor Current	1%	200%		
F013		Accel Ramp Time of Ramp 1	1-120 seconds	1 second	10 seconds		
F014		Max Current Limit of Ramp 1	200 - 600% Motor Current	1%	350%		
F015		Initial Torque (VR) of Ramp 2	0-100% Line Voltage	1%	60%		
F016		Initial Torque (CR) of Ramp 2	0-600% Motor Current	1%	200%		
F017		Accel Ramp Time of Ramp 2	1-120 seconds	1 second	10 seconds		
F018		Max Current Limit of Ramp 2	200 - 600% Motor Current	1%	350%		
F019	Jog Modes	Voltage Jog	5 – 100% Line Voltage	1%	50%		
F020		Time of Voltage Jog	1 – 20 Seconds	1 second	10 seconds		
F021		Current Jog	100 – 500% Motor Current	1%	150%		
F022	Kick Mode	Kick Start Voltage	0 = Disabled, or 10 - 100% Line Voltage	1%	0 Disabled		
F023		Kick Start Time	0.1 - 2 Seconds	0.1second	0.8 sec		

Appendix 6 (cont.) Soft Starter Settings Record

Fn #	Group	Function Description	Adjustment / Display Range	Setting Increments	Factory Setting	Setting	Setting
F024	Pump Flex Decel Mode	Pump Flex Control / Deceleration Ramp	0 = Disabled (coast to stop) 1 = Enabled, except after OL trip 2 = Enabled, continued Decel even if there is an OL trip	1	0 Disabled		
F025		Begin Decel Level (BDL), Immediate Drop Down Torque	0 - 100 % of Output Voltage	1%	60%		
F026		Decel Shut Off Voltage	0 to (BDL minus 1)% Voltage	1%	30%		
F027		Decel Ramp Time	1 – 60 Seconds	1 second	10 seconds		
F028	Restart	Restart Delay Time (Sequential Start Delay)	0 = Disabled, or 1-999 seconds after a Power Loss (Status can be read in F054)	1 second	0 Disabled		
F029		Reserved for Factory Use					
F030	Run Timer and Time Clock Controller Modes	Process Control Timer Selection	0 = Disabled (No timer operation) 1 = Minimum Batch Run Timer 2 = Permissive Run Timer	1	0 Disabled		
F031		Run Timer Time for use in F030 above	1-9999 minutes after a Start Command or Start Event from TCC	1	1		
F032		24hr Time Clock Controller (TCC) Start Event Mode. Chose from “One Shot” or 1 to 7 “Start Events” in F033 – F039 Run time for this mode comes from F030 above.	Start Event Cycle (SEC) Settings 0 = One Shot: Start Event comes from Start command only 1 = Loop SEC every day 2 = Loop SEC every 2nd day 3 = Loop SEC every 3rd day 4 = Loop SEC. every 4th day 5 = Loop SEC. every 5th day 6 = Loop SEC. every 6th day 7 = Loop SEC one day per week 8 = Single 24hr SEC (until programmed again)	1	0 One Shot		
F033		Start Event #1 Start Time	00:00-23:59 (hh:mm) or OFF	1	OFF		
F034		Start Event #2 Start Time	00:00-23:59 (hh:mm) or OFF	1	OFF		
F035		Start Event #3 Start Time	00:00-23:59 (hh:mm) or OFF	1	OFF		
F036		Start Event #4 Start Time	00:00-23:59 (hh:mm) or OFF	1	OFF		
F037		Start Event #5 Start Time	00:00-23:59 (hh:mm) or OFF	1	OFF		
F038		Start Event #6 Start Time	00:00-23:59 (hh:mm) or OFF	1	OFF		
F039		Start Event #7 Start Time	00:00-23:59 (hh:mm) or OFF	1	OFF		

Fn #	Group	Function Description	Adjustment / Display Range	Setting Increments	Factory Setting	Setting	Setting
F040	Current and Ground Fault Protection	Current Imbalance Trip	0 = Disabled, or 5 - 30% imbalance	1%	0 Disabled		
F041		Current Imbalance Trip Delay	1 - 20 seconds	1 second	2 seconds		
F042		Over Current Trip	0 = Disabled, or 100 - 300% of motor FLA	1%	0 Disabled		
F043		Over Current Trip Delay	1 - 20 seconds	1 second	1 second		
F044		Under Current Trip	0 = Disabled, or 10 - 90% of motor FLA	1%	0 Disabled		
F045		Under Current Trip Delay	1 - 60 seconds	1 second	2 seconds		
F046		Ground Fault Trip	0 = Disabled, or 5 - 90% of CT ratio from Fn 74	1%	0 Disabled		
F047		Ground Fault Trip Delay	1 - 60 seconds	1 second	2 seconds		
F048	Lockouts, Reset and Internal Protection	Coast Down (Back Spin) Lockout Timer	0 = Disabled, or 1 - 60 minutes	1 minute	0 Disabled		
F049		Maximum Starts per Hour	0 = Disabled, or 1 – 10 starts	1	0 Disabled		
F050		Minimum Time Between Starts	0 = Disabled, or 1 - 60 minutes	1 minute	0 Disabled		
F051		Internal Protection Settings	1 – 127 See 5.6.9.a	1	127 Enable all		
F052		Auto Reset on Selected Faults	Fault Preferences 1 – 12 See 5.6.9.b Fault Reset Selection Table	1	4: Phase Loss only		
F053		Auto Reset Attempts	0 = Disabled, or 1-10 attempts	1	1		
F054		Restart Delay Time Value Readout (for F028)	0-999 Minutes	1	0		
F055		Coast Down Timer Value for F048	1-3600 Seconds	1	0		
F056		Starts Per Hour Timer Value for F049	1-3600 Seconds	1	0		
F057		Starts Per Hour For F049	1-10 Starts	1	0		
F058		Time Value Between Starts for F050	1-3600 Seconds	1	0		
F059		Thermal Capacity to Start for F005	0-100 % Thermal Capacity	1	0		
F060	Output Relays	Aux Relay 1 setting	Operation # 1 – 26: see ”Aux. Relay Settings Chart”	1	1		
F061		Aux Relay 2 setting	Operation # 1 – 26: see ”Aux. Relay Settings Chart”	1	2		
F062		Aux Relay 3 setting	Operation # 1 – 26: see ”Aux. Relay Settings Chart”	1	16		
F063		Aux. Relay Delay Timer (for Operations 22-26)	0 (Disabled), or 1-999 seconds	1 second	0 No Delay		
F064		Reserved for factory use					

Appendix 6 (cont.) Soft Starter Settings Record

Fn #	Group	Function Description	Adjustment / Display Range	Setting Increments	Factory Setting	Setting	Setting
F065	Communications	Communications	0 = Disabled 1 = Enabled (11Bit) 2 = Enabled (10Bit)	1	0		
F066		Baud Rate	4.8, 9.6 and 19.2 KB	3 rates	9.6 KB		
F067		Modbus Address	1 - 247	1	1		
F068		Remote Starter Control	0 = Disabled 1 = Enabled w/ Start button 2 = Enabled w/o Start button 3 = Enabled by Jog / Remote Input	1	0		
F069		Reserved for factory use					
F070	System Settings	Parameter Lock Customer Password	0 – 999 0 = Disabled Any Other Numbers = Password	1	0 (displays encrypted code)		
F071		System Clear / Reset	0 = Disabled 1 = Clear THR and Lockout Timers 2 = Reset to Factory Default Settings	1	0		
F072		Reserved for Factory Use					
F073		Frame Rating	18 - 550	1	By Model (defaults to 48)		
F074		CT Value	40-1200	5	By Model (defaults to 40)		
F075		Year	2000 - 2047	1 year	2000		
F076		Month	1 - 12	1 Month	1		
F077		Day	1 - 31	1 Day	1		
F078		Hour	0 - 23	1 Hour	0		
F079		Minute	0 - 59	1 Minute	0		
F080		Second	0 - 59	1 Second	0		
F081		Revision #	-	-	Factory Setting		
F082 – F084		Reserved for factory use					

Appendix 6 (cont.) Soft Starter Settings Record

Fn #	Group	Function Description	Adjustment / Display Range	Setting Increments	Factory Setting	Setting	Setting
F085	Fault History and Run Data	Fault History #1, Latest Fault	0 = No fault history, or Fault # 1 - 27: see Fault code list	1	0		
F086		Time Stamp, Fault #1 Based on F078-80	00.00-23.59 (hh.mm) [hh = 00-23; mm = 00-59]	00.01	00.00		
F087		Date Stamp, Fault #1 Based on F076-77	01.01 – 12.31 (MM.DD) [MM = 01-12; DD = 01-31]	00.01	01.01		
F088		Fault History #2, Previous Fault	0 = No fault history, or Fault # 1 - 27: see Fault code list	1	0		
F089		Time Stamp, Fault #2	00.00-23.59 (hh.mm) [hh = 00-23; mm = 00-59]	00.01	00.00		
F090		Date Stamp, Fault #2	01.01 – 12.31 (MM.DD) [MM = 01-12; DD = 01-31]	00.01	01.01		
F091		Fault History #3, Oldest Fault	0 = No fault history, or Fault # 1 - 27: see Fault code list	1	0		
F092		Time Stamp, Fault #3	00.00-23.59 (hh.mm) [hh = 00-23; mm = 00-59]	00.01	00.00		
F093		Date Stamp, Fault #3	01.01 – 12.31 (MM.DD) [MM = 01-12; DD = 01-31]	00.01	01.01		
F094		Run Time, Hours	000.0 – 999.9 hours	0.1 hours	0		
F095		Run Time, 1000 Hour Overflow	0000 – 9999 thousand hours	1 k-hour	0		
F096		Run Cycle Counter	0000 – 9999 times	1 times	0		
F097		Run Cycle Counter 10K overflow	0000 – 9999 10 thousand times	1 10k times	0		

LIMITED WARRANTY
AND
LIMITATION OF LIABILITY

Toshiba International Corporation ("Company") warrants that all equipment and parts described herein will be free from defects in materials and workmanship. THIS WARRANTY WILL EXPIRE TWENTY-FOUR (24) MONTHS AFTER SUCH EQUIPMENT AND PARTS (EXCLUDING REPAIRED OR REPLACEMENT EQUIPMENT AND PARTS FURNISHED PURSUANT TO THIS WARRANTY) ARE PLACED IN OPERATION OR THIRTY (30) MONTHS AFTER THE DATE ON WHICH SUCH EQUIPMENT AND PARTS (EXCLUDING REPAIRED OR REPLACEMENT EQUIPMENT AND PARTS FURNISHED PURSUANT TO THIS WARRANTY) ARE SHIPPED TO THE INITIAL PURCHASER, WHICHEVER PERIOD FIRST EXPIRES. THERE ARE NO OTHER WARRANTIES WHETHER EXPRESS, IMPLIED, STATUTORY OR OTHERWISE, INCLUDING THE IMPLIED WARRANTIES OR MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

The Company will, at its option, repair or replace or refund the purchase price paid for such equipment or part which is defective under the terms of the foregoing warranty, free of charge; provided the purchaser (1) promptly notifies the Company in writing of such defect, and (2) furnishes the Company satisfactory proof thereof, and (3) establishes that the equipment or part has been properly installed, maintained and operated within the limits of rated capacity and normal usage and in accordance with current operating and maintenance instructions , and (4) has not been altered or modified in any manner without the written consent of the Company, and (5) if requested by the Company, returns the defective equipment or part to the Company and pays all expenses incurred in connection with such return. The repaired or replacement equipment or part will be delivered, free of charge, to the purchaser F.O.B. the Company's warehouse or, at the Company's option, F.O.B. a Company authorized service shop, not loaded on truck or other carrier. The purchaser will pay the costs applicable to the equipment or part following such delivery, including, without limitation, all handling, transportation assembly, insurance, testing and inspection charges.

THE FOREGOING OBLIGATION TO REPAIR OR REPLACE EQUIPMENT PARTS SHALL BE THE SOLE AND EXCLUSIVE REMEDY OF THE PURCHASER, ITS CUSTOMERS AND USERS OF THE EQUIPMENT AND PARTS FOR BREACH OF THE FOREGOING WARRANTY. THE COMPANY WILL HAVE NO OBLIGATIONS TO DISASSEMBLE ANY EQUIPMENT OR PART WHICH IS DEFECTIVE WITHIN THE TERMS OF THE ABOVE WARRANTY OR TO INSTALL ANY REPAIRED OR REPLACEMENT PART OR EQUIPMENT OR TO PAY ANY COSTS INCURRED IN CONNECTION WITH ANY SUCH DISASSEMBLY OR INSTALLATION. THE COMPANY, TOSHIBA CORPORATION AND THEIR SUPPLIERS AND SUBCONTRACTORS HEREBY DISCLAIM ALL OTHER EXPRESS, STATUTORY AND IMPLIED WARRANTIES, INCLUDING, WITHOUT LIMITATION, ALL EXPRESS, STATUTORY AND IMPLIED WARRANTIES, SUCH AS MERCHANTIBILITY AND FITNESS FOR A PARTICULAR PURPOSE APPLICABLE TO ALL REPAIRED OR REPLACED EQUIPMENT AND PARTS FURNISHED PURSUANT TO THE FOREGOING WARRANTY.

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